POWER

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Indispensability

By RUFUS T. STROHM

A gnat upon its errant way
Flew through an engine room one day
  And settled on the flywheel,
Which weighed some twenty tons or more
And stood twelve feet above the floor—
  A massive, broad and high wheel.

But scarcely had his trotters hit
The smoothly polished top of it,
  Than off it started whirling,
While on its speeding rim the gnat
In happy contemplation sat,
  His natty mustache twirling.

"Hi, people! Turn your eyes on me!"
He cried in Lilliputian glee.
  "Just notice what I've started.
It's plain that I'm a heavy-weight
To turn this thing at such a rate
  Of speed as I've imparted."

"And what is more, I'll have you know
That I'm the guy that makes it go"—
  He said it very loudly.
And thereupon, to prove his case,
He sprang from off its gleaming face,
His chest expanded proudly.

Gadzooks! That gnat was fairly floored!
The throbbing engine quite ignored
  Its self-appointed master;
Not for a second did it stop
Nor let its speed of turning drop;
  Instead it ran the faster.

You doubtless know some human gnat
Who acts as foolishly as that,
  And gets the silly notion
That no one in the firm but he
Provides the push and energy
  That keeps the thing in motion.

Less learned folks to us may bow
And subtle flatterers kowtow
  In manner deferential;
But though possessed of wit and brain,
It's downright folly to be vain—
  We're none of us essential.

When any mortal comes to think
The world would all go on the blink
  Were he assassinated,
He's on the old toboggan slide
Whose sloping length is steep and wide
  And smoothly lubricated!

Coal Consumption in Institutional Heating Plants

By G. B. NICHOLS
Chief Engineer, New York State Dept. of Architecture

FOR the last ten years, in state and municipal work, a great deal of attention has been given to the centralized control of all activities, replacing the local controls at each institution to a greater or less extent. This has been forced upon the state on account of the extensive research now being carried on, demanding specialized control in each branch of government. One of the main departments of centralized control which has been established in a number of the states is the Department of Architecture, under a state architect, which department can be divided into three main divisions—architectural, administrative and engineering. This article will deal with the engineering division and its relation to the operating conditions at the various institutional heating, lighting and power plants. Such a division is also applicable to one which might be established in a large corporation operating plants scattered over a widely distributed area.

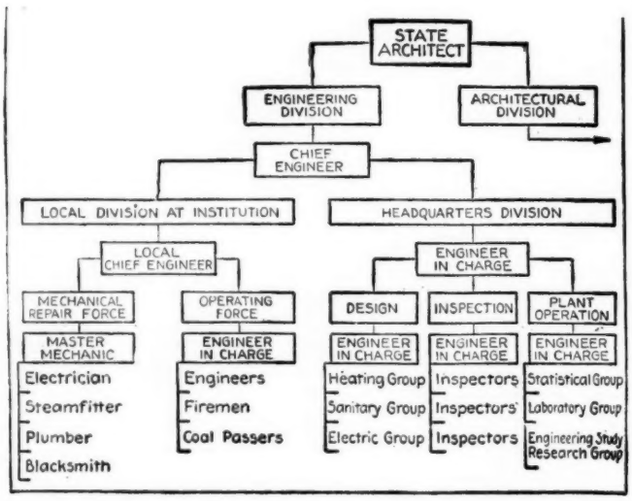


FIG. 1. DIAGRAM OF ORGANIZATION OF THE DEPARTMENT OF ARCHITECTURE AS RELATING TO THE ENGINEERING DEPARTMENT

Such an engineering division, or department, should be under the direct administration of a headquarters chief engineer, two distinct divisions reporting to him, the first of which would be the headquarters division, which would be divided into three bureaus, each under an engineer, in charge, namely, the division of design, the division of inspection and the division in charge of power-plant operation. This is shown in Fig. 1.

Each of these divisions would require specially trained experts, and it is found impossible to shift employees between these divisions, as the employees of each class must have their particular training, and it is found that a good designing engineer seldom makes a good inspector. An engineering inspector very seldom is disposed to draw up a design on a drafting table, as he soon gets lost in the details, so that a rule can be laid down that each division must train its own employees.

Acting under the headquarters chief engineer, at the institution and local plant, is a local chief engineer, and reporting to him are two groups of employees, one group consisting of the plant-operating force acting under an engineer in charge of operation, and the other group, the mechanics making repairs to the general plant, under a mechanical foreman. The same condition exists in the training of these two branches of employees, as a repair man seldom makes a good operating engineer.

All these divisions, however, must act as a unit, each depending upon the others for advice and guidance in its particular branch of work, the headquarters chief engineer acting as an administrator to the entire group, and the local chief engineer and headquarters bureau engineers each realizing that they are units of a large collective body, carrying on the state engineering work. It is believed at the present time that to a greater or less extent this harmony exists in the various institutional plants and headquarters engineers under the control of the State of New York, and that the foregoing outline of divisions will become a reality as time goes on, particularly on account of the high cost of material entering into the operation of the plants, thereby demanding the highest efficiency of the entire engineering division of the state, which is impossible with local control. The medical profession and local institutional administrators also realize that the functions being performed by the engineering staff are wholly outside of their training, and that all technical problems arising must be given mature engineering consideration.

Few persons outside of those actively engaged in state work realize to what extent state institutions have grown. In New York State, in the insane hospitals alone, there are now housed approximately 35,000 patients. Three of these institutions have a population of approximately 5,500 inmates each, and in each the maximum coal consumption per day in extreme cold weather is about 90 tons.

The last bureau to be established by the Engineering Division of the New York State Department of Architecture is the headquarters division in charge of operating conditions of the various heating, lighting and power plants of the state. This bureau has been actively engaged for a considerable period in studying the operating and apparatus conditions at the various institutional plants and endeavoring to arouse in all of the operative force a spirit of coöperation and a study of the plant condition, with the idea of reducing the operating cost, particularly the annual coal consumption and labor.

The first work of the bureau in charge of operation was to prepare a series of daily log sheets applicable to all plants, in which would be entered all the instrument readings, together with the coal and ash consumption and the amount of labor required for each shift. One of these forms is shown in Fig. 2. All the report sheets can be bound into a loose-leaf post binder cover and are filled out by the local operating force in dupli-

cate, one copy to be bound in the binder and kept in plain sight in the engine room for the study by all the operating force, so that the plant condition is known by each individual employed and he can definitely see his relation to the final operating costs.

The duplicate copy is sent to the headquarters bureau and is bound in a similar loose-leaf book and carefully observed by a specially trained force who plot curves showing all the operating conditions about the plant and make a summary of all daily reports at the end of each month at which time the local chief engineer receives a summary report of the operating conditions for the month, in total, also in per capita, based on the inmates at that particular institution. Along with this report is sent a series of definite recommendations to be tried out by him and the results of these recommendations reported on in writing to headquarters before the first of the next month. It can, therefore, be seen that the headquarters engineering force in charge of operations are familiar with all the conditions at the plant and can compare one plant's operation with that of a similar institution at another locality, and if there is a great difference in final per capita or efficiency results, immediate steps can be taken to either right or account for this difference.

As the records increase in number, the results of one year can be compared with those of a previous year at the same date, or same month. It can also be seen that the headquarters staff act as bookkeepers for the local operating force.

Can Increase Coal Consumption

Although a plant may be much out of repair, and wasting steam and demanding a large amount of coal to run, still the results show that to a great extent the operating force can by inattention or neglect of their work or possibly through misunderstanding of the proper methods to be employed in the operation of a certain piece of machinery, materially increase the coal consumption; and it is the duty of every engineer to study the apparatus under his control and to make it operate at its greatest efficiency.

In 1915 numerous discussions were carried on by the state departments regarding the condition of the institutional plants and their operation, and numerous cases were pointed out in which the annual coal bills were continually increasing without any additional building construction being carried on at such institutions. Also that by simply changing a local chief engineer, the coal bills immediately increased or decreased, due to his inattention or activity. About this time investigations were carried on by several engineers and a report was

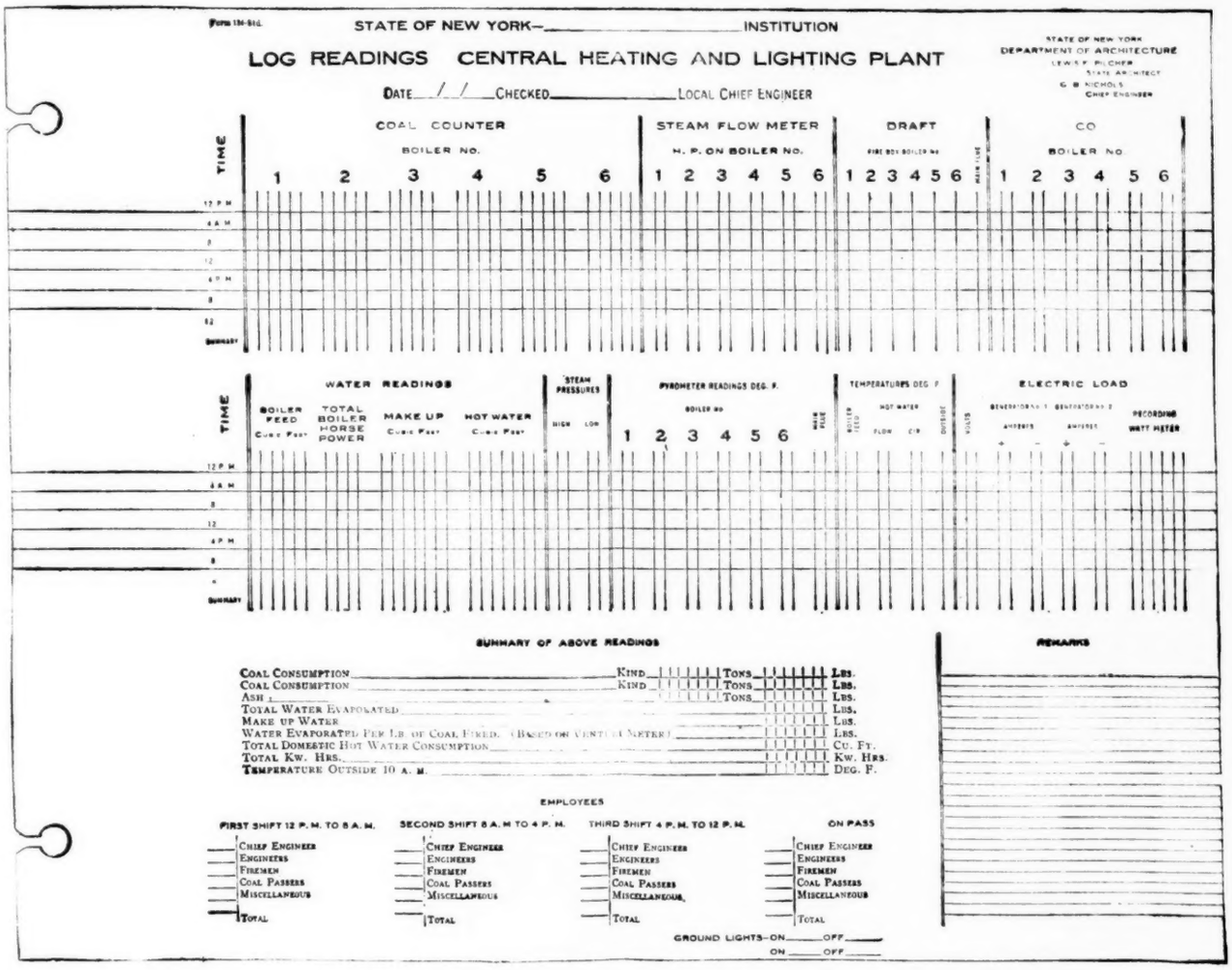


FIG. 2. ONE OF THE DAILY LOG SHEETS THAT IS APPLICABLE TO ALL STATE PLANTS

made by John A. Hennessy in his published book on the conditions in New York State, which book states that as a result of three investigations, it was believed that approximately $300,000 a year spent for fuel could be saved in the proper operation of the state heating and lighting plants.

On account of war conditions and the reduction of employees in the various state institutions, it was found impossible to carry on this work with any great activity, but it was not altogether dropped. At the close of the war, however, it was believed that the time was ripe for the undertaking of centralized control of these power houses, to a greater or less extent, making it possible to reduce the coal bills and also to furnish the design department with the actual operating conditions at the various plants, for the design department is continually called upon to make additions, alterations or repairs to all these existing plants. These operating reports also form the basis of new designs, and it is felt that at the present time there are on file more actual facts regarding all classes of services required at a state institution on which to base new designs than existed before, and this information is being sought by other states and private concerns. A recent report of this activity is as shown in the accompanying tabulation covering ten hospitals.

TOTAL SAVINGS IN TEN HOSPITALS

State Hospitals	Estimated Tons Consumed	Estimated Tons Saved Over 1918-19	Saving in Dollars
Binghamton	13,495	337	$1,240.16
Brooklyn	4,577	397	2,354.21
Buffalo	12,081	559	1,928.55
Gowanada	10,354	1,741	8,705.00
Hudson River	19,051	2,295	11,429.10
Kings Park	22,881	2,285	10,922.30
Manhattan	19,800	19,584	145,509.12
Middletown	10,426	2,333	10,101.89
Rochester	7,646	471	2,425.65
St. Lawrence	14,719	1,323	6,284.25
	135,030	31,325	$200,900.23

Saving over total coal consumption in 1918-19 of 220,015 tons or 14.2 per cent.

The summary of the foregoing figures shows that an estimate of 31,325 tons of coal will be saved which, with the prices of coal prevailing at the respective institutions, will mean a saving for 1919-20 of $200,900. These ten plants represent approximately two-thirds of the coal consumption of the state, and it appears, therefore, that the estimates made in 1915 were correct.

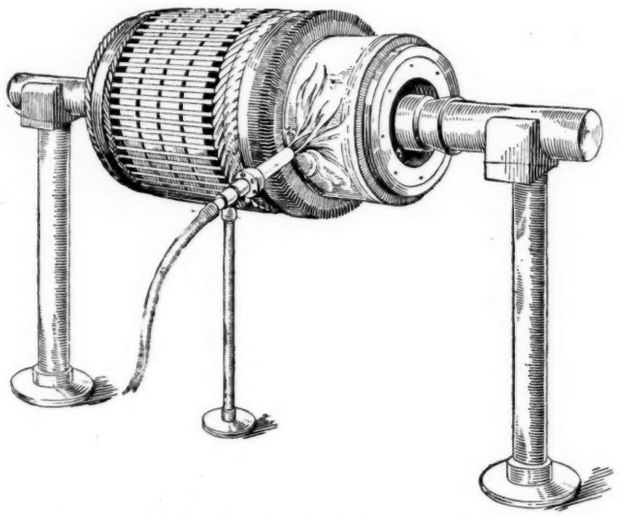
It is safe to say that if owners of heating plants will encourage their engineers to make a careful study of their operating condition, furnishing them with the necessary repairs, so as to stop steam leaks, log-reading charts for recording all instrument readings, and will also furnish them with the proper measuring instruments so that they can study their plant conditions, the percentage of saving will be equal that shown on the foregoing schedule. It is believed, however, that in large corporations, having a number of separated plants, a central headquarters bureau is an absolute necessity to carry on the bookkeeping and analyzation of the operating condition of the plants. If, however, it is a single plant, a substitute for this central bureau would be for the plant to be under the control or advice of a privately owned controlling bureau performing this function for this separately owned plant.

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, estimates the total value of exports of refrigerating machinery during February, 1920, at $2,817,117. Japan was the largest purchaser during this month, followed by Cuba.

Unsoldering Leads from Commutator

BY B. A. BRIGGS.

Disconnecting the leads from the commutator of a large armature with a soldering iron is a rather slow job on account of the large amount of metal that must be heated and also because of the rapid transfer of heat to the body of the commutator. The work can be considerably hastened by applying heat to the body of the commutator, by means of a blowtorch or a gas heater, as indicated in the figure. A piece of thin sheet asbestos should be placed around the surface of the commutator to prevent the flame from injuring the insulation. In this way the commutator may be heated up to near the melting point of the solder so that there is very little to be done with the iron and the rate at which the leads can be removed is greatly increased.



HEAT BEING APPLIED TO THE COMMUTATOR BY A GAS FLAME

Diagram for Computing Thickness of Plate for Steel Pipe

BY WILLIS T. BATCHELLER*

The accompanying chart was prepared in connection with the design of the steel penstock for the new unit of the Cedar Falls hydro-electric plant[1] of the city of Seattle. The penstock was 2,226 ft. long and was made up in different diameters, ranging from 66 in. to 78 in. The static head varied from 250 ft. to 627 ft. at different points. While the solution is simple, the use of the diagram saves a great deal of labor when a number of values must be computed.

The thickness of steel pipe was computed by the equation

$$T = \frac{D \times H \times 0.434}{2 \times S \times E}$$

in which

T = Thickness of pipe in inches;
D = Inside diameter of pipe in inches;
H = Maximum static head on pipe in feet;
0.434 = Pressure in lb. per sq.in. for one foot head;
S = Fiber stress in plate;
E = Efficiency of joint.

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[1]This plant was referred to in an article by the author in the Sept. 4, 1919, issue of *Engineering News-Record*.

Using the equation given, values were computed and curves plotted covering the useful range of conditions. The curves are equally applicable to lock-bar pipe, lap-welded steel pipe and riveted steel pipe when the proper joint efficiency is used for the special case in hand.

The use of the diagram is illustrated by the following example: It is required to find the thickness of steel plate for a pipe having an inside diameter of 78 in. under a maximum static head of 500 ft. using a fiber stress in the plate of 15,000 lb. per sq.in. and a joint efficiency of 80 per cent, corresponding to a triple-riveted butt joint. Starting at a pipe diameter of 6½ ft., follow the vertical line to its intersection with the line representing a head of 500 ft. Then move along the horizontal line to its intersection with the line of 15,000 lb. fiber stress and drop vertically to the 80 per cent efficiency line. Follow the horizontal line to the left, where it intersects the thickness scale, and read $\frac{7}{16}$ of an inch or $\frac{1}{16}$, the nearest fraction. In the case of single-riveted or double-riveted lap joints under the same conditions, produce the vertical line to its intersection with the 50 or 65 per cent line, respectively, and read 1$\frac{1}{8}$ in. and $\frac{7}{8}$ in. for the two examples. With lock-bar pipe the thickness may be obtained by using a joint efficiency of 85 per cent and with lap-welded steel pipe, 90 per cent. In case it is desired to add $\frac{1}{16}$ in. or some other amount as a rust factor, this can be done after the result is obtained from the diagram.

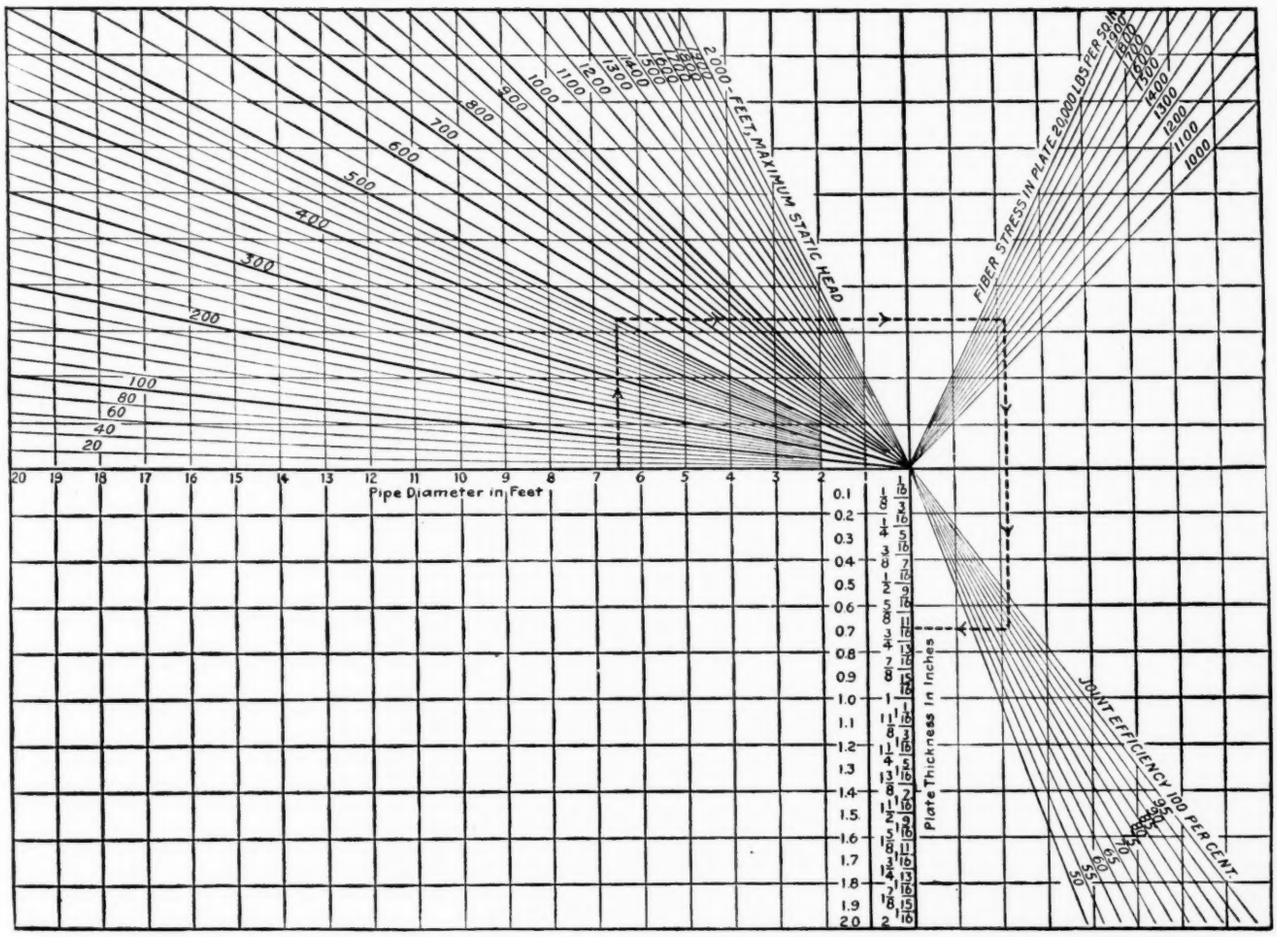


DIAGRAM FOR COMPUTING THICKNESS OF PLATE FOR STEEL PIPE UNDER VARIOUS CONDITIONS

EFFICIENCIES OF RIVETED JOINTS

Thickness of Steel Plate	Lap Joints			Butt Joints		
	Single-Riveted	Double-Riveted	Triple-Riveted	Double-Riveted	Triple-Riveted	Quadruple-Riveted
¼	57	72	80	81.6	87.5	94.3
5/16	54	70	77	80.3	88.0	94.6
⅜	53	69	76	80.8	87.5	93.3
7/16	51	67	76	80.2	86.1	93.7
½	50	66	74	80.7	85.8	94.0
9/16	48	65	73	80.1	86.0	94.0
5/8	..	..	..	.....	86.3	93.1
11/16	..	..	..	.....	84.7	92.4
¾	..	..	..	.....	84.1	91.1
13/16	..	..	..	.....	82.8	90.8
⅞	..	..	..	.....	82.5	89.1
15/16	..	..	..	.....	81.7	87.8
1	..	..	..	.....	81.0	87.3
1 1/16	..	..	..	.....	.....	86.3
1 1/8	..	..	..	.....	.....	85.4
1 3/16	..	..	..	.....	.....	84.5
1¼	..	..	..	.....	.....	84.0

Any problem containing a single unknown quantity can be solved by the use of the diagram. In case it is desired to obtain more accurate results than those resulting from the use of the conservative values of efficiency given herein, a trial thickness may first be obtained by their use and the operation repeated, using the joint efficiency corresponding to the trial plate thickness. To facilitate this use of the diagram, the accompanying table of joint efficiencies for ordinary commercial plate thicknesses has been taken from tables prepared by the Hartford Steam Boiler Inspection and Insurance Company.

Public utility companies operating in northern Illinois suffered damage amounting to about $1,000,000 during the windstorm on March 28.

Short Manometer for Measuring High Pressures

FOR the accurate measurement of pressure or of differences in pressure a manometer or U-tube becomes inconveniently long when the pressure is more than 45 or 50 lb. per sq.in. Dr. H. C. Dickenson, physicist of the Bureau of Standards, recently described a form of manometer used at the bureau, which overcomes this difficulty. The principle of this instrument is the use, in series, of several manometers of reasonable length so connected that any number of them may be used.

The general appearance of the apparatus is shown in Fig. 1 and a diagram of the connections in Fig. 2. There are five main U-tubes, each of which has an effective length of about 100 in., and two auxiliary tubes (*C* and *D*), each of which has about 12 in. readable length. The measuring liquid used is mercury, and the pressure is transmitted from one tube to the next by oil or pure ethyl alcohol, the latter liquid being more satisfactory since less dirt collects on the mercury surfaces with alcohol than with oil. The auxiliary tubes *C* and *D* are provided so that the instrument may be used in measuring gases which would be absorbed by the oil or alcohol. The portions of the manometer in which the mercury surfaces are observed, consist of glass tubing, 10 mm. (about 0.4 in.) inside diameter, while the remainder of the glass tubing is about 2.5 mm. (about 0.1 in.) inside diameter. Tube No. 5 is designed to be read at any pressure between zero and 45 lb. per sq.in., while the other four may be read only near the ends, and each tube is used to contribute an additional 45 pounds.

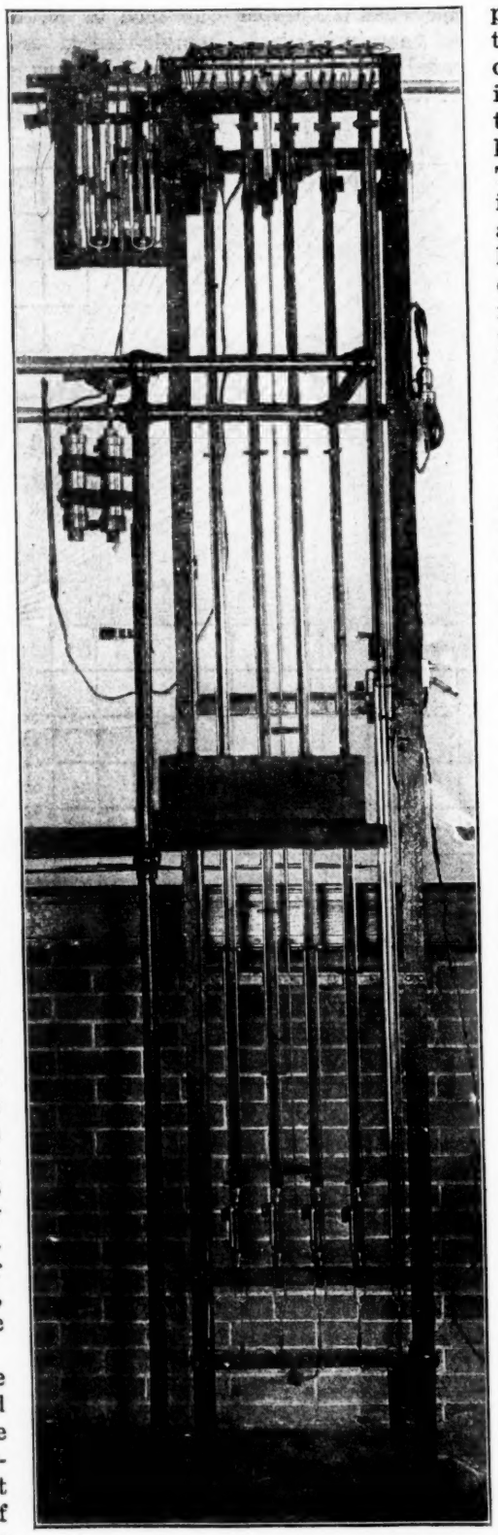


FIG. 1. HIGH-PRESSURE MANOMETER AT THE BUREAU OF STANDARDS

In operation the high-pressure gas is admitted to the left-hand tube of the manometer *C*, where its pressure is exerted on the surface of the mercury. To prevent the mercury being blown out of the tube *C*, oil is pumped in by the pump *P*, through the valve V_{11} until the pressure in the right-hand side of tube *C* is sufficient to keep the mercury level in the two tubes approximately the same. The pressure is thus transmitted by the oil from the mercury in the right-hand member of tube *C* to the left hand side of tube No. 1. Oil is delivered from the pump *P* through the valve V_{12} until the pressure at B_1 is sufficient to keep the mercury from being blown out of tube No. 1. The pressure at B_1 is then transmitted by the oil to the mercury surface in the left-hand member of tube No. 2 at A_2. The remaining pressure is similarly transmitted through tubes 3 and 4 to the surface in the left-hand member of tube 5, the mercury column in each of the first four manometers reducing the pressure by approximately 45 lb. per sq.in., or by a total of approximately 180 lb. per sq.in. Any excess in pressure over the 180 lb. is measured in manometer No. 5.

In case a pressure between 135 and 180 lb. was to be measured, the valve V_1 would be opened, thereby bypassing tube No. 1 so that only tubes 2, 3, 4 and 5 would be used. Similarly, for still lower pressure tubes 2, 3 and 4 might also be bypassed. It might be noted that if one or more tubes are to be bypassed, the effect is the same no matter which of the tubes are cut out.

In operating the manometer the valve V_6 is always closed except when it is desired to equalize the pressure between the two sides of the instrument. The valves V_7 and V_8 are opened only to change the volume of the transmitting fluid, and thus regulate the mercury levels in *C* and *D*. Valves V_9 and V_{10} exclude the pressure from the main portion of the manometer and, as a precaution in the event of breakage, are usually kept closed except during the period of observation. The effect of pumping in transmitting fluid through V_{11}, V_{12}, V_{13}, V_{14} or V_{15}, is to increase the difference in the height of the mercury surfaces for each tube to the right of the valve used, and to decrease the same for each tube to the left.

The reading device consists of a brass collar which encircles the tube of mercury. Behind the collar is attached a white background illuminated by a small electric lamp. The collar is moved up or down until the observer is just able to see a line of light between it and the mercury meniscus. The reading of the index on the fixed scale is then observed. A steel tape 2.8 m. long (about 71 in.) is stretched behind the U-tube No. 5, a 10-cm. scale (about 4 in.) is mounted behind each of the readable portions of the other four

tubes, and a 20-cm. scale (about 8 in.) is mounted behind each readable portion of the auxiliary tubes. With this arrangement, the readings of the manometers Nos. 1, 2, 3 and 4 must be corrected by the addition of the vertical distance between the zero points of the two scales.

A further correction, due to the weight of the column of transmitting fluid, is necessary. For example, in tube 1 there is a column of oil in the left-hand tube from the mercury surface at A_1 to a point on a level with B_1. The oil in the left-hand tube above this level is of course balanced by the oil in the right-hand tube. The correction is then equal to the difference between gravity of the oil to that of mercury. This correction is always to be subtracted and must be made for each the mercury levels multiplied by the ratio of the specific manometer.

The reading of the total pressure shown by the entire instrument is of course the sum of the corrected

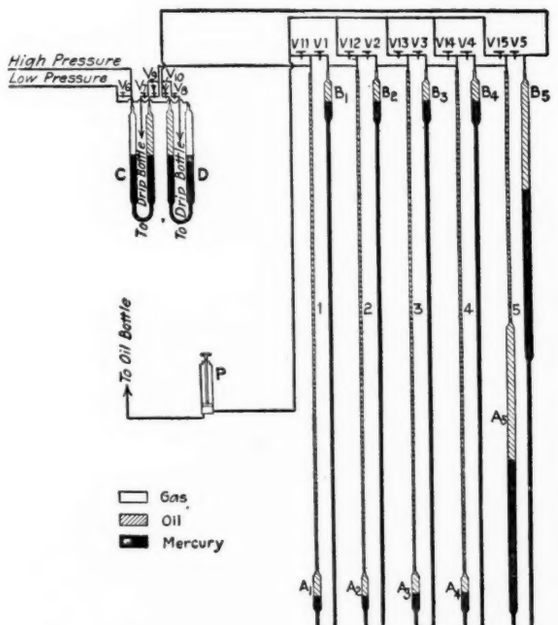


FIG. 2. DIAGRAM SHOWING ARRANGEMENT OF HIGH-PRESSURE MANOMETER

pressures read from each of the manometers used. For extreme accuracy the reading must be also corrected for the temperature of the mercury. At the Bureau of Standards this is determined by a special thermometer mounted vertically behind the middle of the manometer. Since an air circulating fan maintains a temperature that does not differ more than 0.5 deg. in various parts of the room, the temperature measurement is believed to be accurate to 0.3 or 0.4 deg. Another correction considered is that made necessary by the compression of the fluid under the higher pressure. From data on the compressibility and densities of mercury, oil and alcohol, the error in measurements of pressure differences at a mean pressure of 1,500 lb. per sq.in. is four parts in 1,000,000 for mercury and oil and 140 parts in 1,000,000 for mercury and alcohol. This correction, therefore, may be neglected in any but the most refined measurements. The greatest source of error appears to be in the actual determination of the position of the various mercury surfaces. With the reading devices used, the position of a clean surface can be determined to 0.1 mm. (about 0.004 in.). However, dirt will increase this uncertainty to perhaps as much as 0.3 mm. (about 0.012 in.). Since for 225 lb. pressure there are fourteen surfaces to be read, the probable error of reading will be from 0.5 to 1.5 mm. (0.02 to 0.006 in.), or about one part in 10,000. A series of experiments was undertaken to show the error due to the lag of the manometer. It was found after three or four minutes the errors from this source were much less than those from other known sources.

Installation and Maintenance of Trash Racks for Hydraulic Power Plants

BY RONALD V. MCDONALD

Trash racks of hydro-electric developments are installed to protect the water turbines, governing apparatus and equipment and plant. If improperly chosen or installed, they may fail when needed most; if not properly maintained, they may obstruct the flow of water and even shut down turbines. These racks are installed before, or in, the intakes to prevent trash—vegetation, wood and other water-borne débris—being carried down through the intake. The form of rack used should depend upon the form of débris that may come down and the velocity with which it is carried by the water.

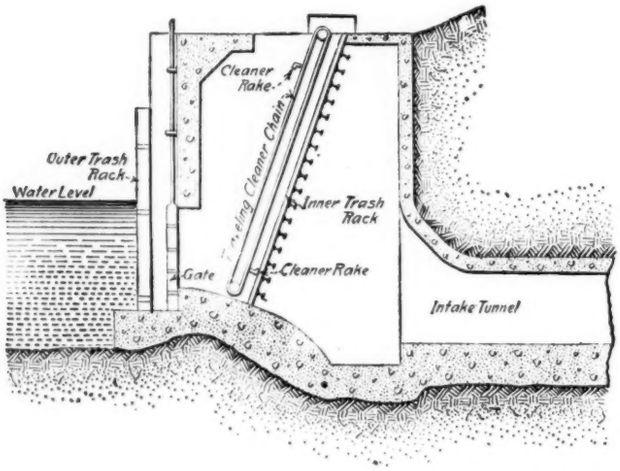
A common form consists of 1¼-in. round iron bars, set vertically, to the top and bottom of which are riveted flat iron bars about 4 in. wide and ⅜ to ½ in. thick. The circular bars are usually spaced about 4 in. apart. Another common form of rack is similar to the foregoing, except that the grids or vertical bars are from ⅜ to ½ in. wide transversely to the water flow and 3 to 4 in. thick in the direction of flow. The former type is invariably built up in a blacksmith shop; the latter is usually cast or forged in one part. The former is the cheaper and more easily made and repaired; the latter probably offers the maximum strength of rack with a minimum obstruction surface for restricting water flow.

A trash rack should be designed to offer maximum obstruction to débris and foreign matter brought down by the water and minimum resistance to the passage of water. These two requirements are somewhat antagonistic, a condition often solved by installing two racks, the inner one of finer grating, thus not only lessening the likelihood of obstruction of water taking place, but also facilitating cleaning. The space between grids or bars of a rack should depend upon the obstructions to be guarded against, the size of unit to be protected and the velocity of the incoming water and water-borne obstructions. Where ice jams and logs, turbulent water and wind are expected to be encountered, the racks should have ample strength, for grids that become bent together result in an obstructed passage between which invariably forms the nucleus for a blockade of vegetation.

A trash rack should be designed to give sufficient passage for water passing through it of the desired quantity without excessive loss of head. It is surprising what loss of effective head will actually occur when vegetation, wood and other materials clog the intake, a condition that assumes particular importance in low-head hydro-electric developments. Loss of efficiency and capacity always follows, and a unit may be shut

down entirely from this cause. I believe that where much vegetation is to be dealt with, it is advisable to design the trash rack so that if it be obstructed equivalent to 40 per cent water restriction, the necessary flow of water is still possible.

Coarse stationary trash racks are usually cleaned by hand, using a rake on a pole or handle for this purpose.



TYPICAL TRASH RACK ARRANGEMENT WITH CONTINUOUS CLEANING DEVICE

Sometimes a rake similar to a harrow is used, hung from chains by a hoist so as to permit of being lifted by one or two men. When two trash racks in series are employed, it is a good policy to make the inner or finer rack self-cleaning, in much the same way that soot cleaners are supposed to keep economizer heating surfaces clean. This is generally accomplished by one or more rake-like appliances (made in the blacksmith shop) installed upon link chains, which in turn are driven from a motor-operated countershaft located on top of the intake structure. Some form of adjustable iron comb is installed on top of each bay to catch the trash brought up by the scrapers and drop it on the floor.

Where hydro-electric developments receive their water from rivers adjacent to industry and habitation, a condition existing in the East and Middle West to much greater extent than on the Pacific Coast, trouble with the trash racks is often encountered on account of corrosion of the intake screens and racks. In some cases this sort of corrosion is very persistent and rapid, and from reports, no sort of paint has as yet been found that will remain an impervious covering for the metal for any great length of time.

About the best manner of delaying corrosion by the contamination of industry and habitation seems to be to paint all metal work with a heavy red-lead covering. This makes a good coating and lasts reasonably well, notwithstanding erosion and attrition by water and foreign matter. Racks and screens to remain protected should receive attention, and possibly repainting, once each year. As screens and racks cover a comparatively large surface, yet comprise but little metal relatively, painting by hand is most tedious if done thoroughly and is often slighted. Time and paint may be saved and a better job done by employing a paint-spraying outfit. The larger and greater the number of racks, the more advantageous a spraying outfit becomes, obviously. Before applying the paint, all metal work should be thoroughly cleaned by sand-blast.

The writer has never seen galvanized-iron trash racks used, probably for the reason that racks are made up close to the job, and galvanizing is not readily performed under such conditions. It is suggested that the contractors for the water turbines or other hydraulic apparatus might include the trash racks and furnish them galvanized, at least in a few cases as an experiment.

Many hydro-electric plants have been forced to curtail output, in some instances even being obliged to shut down temporarily, because of obstructed trash racks. Probably most hydro-electric plants have at some time suffered from loss of head because the trash racks were clogged and kept on clogging as fast as they were cleared. The foregoing may help to improve the situation by bringing up for discussion a few phases of the problem.

How To Locate Faults in Direct-Current Armatures

BY W. A. DARTER

A very convenient, sure and quick method of locating faults in armatures, such as short-circuits, open-circuits, poor contacts, grounds and cross-connected coils, without opening any coil connection to the commutator, is to use an ordinary telephone receiver and a source of alternating current. The principle is very simple. If an alternating current is sent

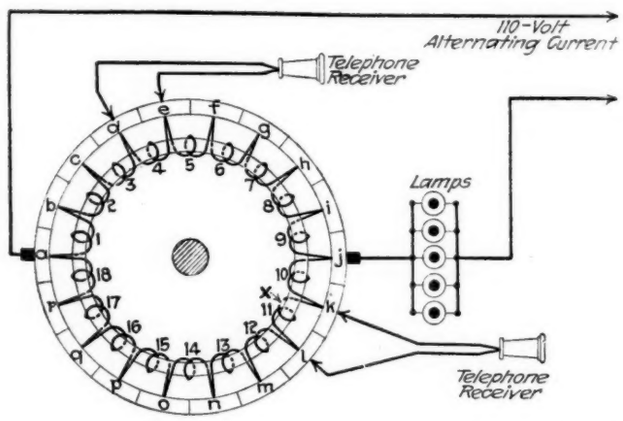


FIG. 1. CONNECTIONS FOR MAKING SHORT-CIRCUIT AND OPEN-CIRCUIT TESTS

through a coil, there is a voltage drop across the leads of the coil, and by connecting the leads of a telephone receiver across the leads of the coil, a vibration is set up in the receiver caused by the alternating current passing through it due to the voltage drop. Consequently, if a coil is short-circuited, there will be no voltage drop across the leads, and hence if the coil leads are bridged by the telephone-receiver leads, there will be no sound produced in the receiver.

For testing large armatures with coils of low resistance, a sensitive receiver is necessary. Small armatures may be tested with any telephone receiver and a small exciting alternating current. The writer generally uses a 110-volt source of energy, with either an ordinary electric iron in series with the armature coils,

or enough large-current lamps in multiple to give the required amount of exciting current.

The leads of an alternating-current circuit are connected to the commutator the same distance apart as the brushes. On a two-pole machine the leads are connected 180 deg., on a four pole machine, 90 deg., and on a six-pole machine, 60 deg. apart. To detect a short-circuited coil in a 5- or 10-hp. armature, pass about a five-ampere current through the coils, as shown in Fig. 1. Then, beginning at commutator segments *a* and *b*, bridge the coil with the receiver leads. Continue to bridge each coil until the receiver fails to vibrate. If coil No. 4 is short-circuited due to a burr between segments *d* and *e*, then the receiver will fail to vibrate, indicating that there is no voltage drop between these two points, and hence coil No. 4 is short-circuited. Generally, after a commutator has been machined down, several of the segments are bridged together with small pieces of copper, and testing out the armature before it is put into service insures against any trouble from this source.

To detect an open-circuited coil, connect the armature up as shown in Fig. 1. Bridge each coil in rotation around the commutator until the receiver makes or produces a violent vibration. This violent vibration indicates an open in the coil, and the receiver is subjected to the full-voltage drop in that side of the armature. If the receiver leads bridged segments *k* and *l*, a strong vibration would indicate that coil 11 is open at some point, such as at *X*. To detect bad contacts between the coil leads and commutator segments in an armature, connect the same as in Fig. 1, then bridge each coil as before, tapping the commutator at the

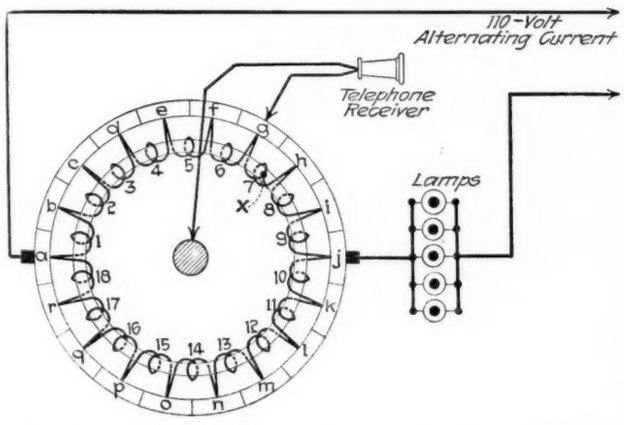


FIG. 2. CONNECTIONS FOR MAKING GROUND TESTS

same time with a wooden mallet. If there is a bad contact, the intensity of the receiver's vibration will vary, due to the change in resistance of the contact.

To detect a coil or commutator segment that is grounded, connect the armature to the alternating-current source, as shown in Fig. 2, which is the same as Fig. 1. Then connect one lead of the receiver to the shaft and with the other lead locate the segment that will give the minimum intensity of vibration in the receiver. This indicates the least voltage drop and that either the segment or coil connected to it is grounded. In Fig. 2 segments *g* and *h* would give about the same intensity of vibration; this would indicate that the coil winding is grounded about midway between the two.

To detect coils that are cross-connected to the commutator as shown at *g* and *h*, Fig. 3, connect the alternating-current source across the commutator and with the receiver bridge the segment as when testing for short-circuits. A cross-connected coil will be indicated by a normal vibration between two excessive vibrations in the receiver. This will be understood from the figure. If the receiver is connected to segments *f* and

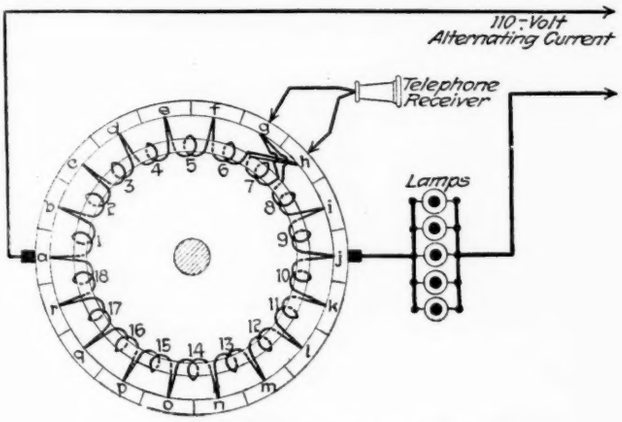


FIG. 3. CONNECTIONS FOR LOCATING CROSS-CONNECTED COILS

g, it will be connected across coils 6 and 7 in series. When the receiver is connected to segments *g* and *h*, it is across coil 7 only, and when in contact with segments *h* and *i*, the receiver bridges coils 7 and 8. Hence, under the first and third conditions the potential drop across the segments will be twice as great as under the second condition, and give indications in the receiver accordingly.

As a means of minimizing the difficulties caused by the insufficient coal supply the various electrical companies in and around Paris are considering a proposal for the construction of a vast power station for the distribution of energy throughout the industrial area which has grown enormously in importance since the war, says *The Engineer*. The existing power stations are wholly insufficient for present needs, and it is often urged that the defective installations are as much the cause of the irregular service as the shortage of fuel. It is hoped that by creating a central power station capable of supplying the entire Parisian district there will be, first of all, an economy of coal, and, secondly, it will be easier to insure supplies which would not be distributed among so many companies as at present. Nevertheless, it is argued that this economy and convenience would be purely illusory, and it has been proposed to generate electrical energy in some center like Rouen, where coal can be procured at lower cost and without additional transport, and distribute the current to the Paris district. The supply of electrical energy in and around Paris is so defective that something will have to be done to avoid the serious loss to the engineering and other industries resulting from the frequent stoppages.

A gigantic pool of power companies of the city of Los Angeles and all southern California is being planned. At a conference under the supervision of the State Railroad Commission to be held soon, the arrangements will be completed.

Charts for Graphical Determination of Pipe Sizes and Velocity of Flow of Steam

By H. M. BRAYTON
Mechanical Engineer and Designer, Semet Solvay Company, Syracuse, New York.

The author gives two charts for determining the size of pipe and velocity of flow for all usual pipe sizes. He also shows how the reader may construct such charts.

THE flow of steam in pipes is a complicated problem. One may delve as deeply as patience and one's knowledge of the subject goes into the thermodynamic theory. Many times in such a study assumptions have to be made which are not well supported by experiment and for this reason make the final result still in doubt. Such factors as the coefficient of friction between the steam and the pipe walls, which varies with the velocity, the character of the steam and the smoothness of the surface, the quality of the steam, the heat loss by radiation and conduction, the size and length of the line and the pressure, all affect the flow in a greater or less degree.

It is not the purpose of this article to carry the reader on any such mathematical journey as would be necessary in a discussion of the theory of the subject. It is rather the aim of the writer to show how the factors usually desired in steam-flow calculation may be determined graphically without calculation of any kind and with a degree of accuracy that will suffice in most practical cases. There are many men working at the drawing board whose knowledge of mathematics is limited, and to them these charts will be found of special value. Even the trained engineer does not like to spend his time in going through routine calculation when it may be avoided. The use of graphical charts as time savers is coming more and more to be recognized by technical men.

The variables involved in pipe-size determination are as follows: Steam pressure, specific volume or the number of cubic feet per pound at the given pressure, the total weight of steam flowing in pounds per minute, the quantity flowing in cubic feet per minute and the velocity of the steam in the pipe in feet per minute. With these all known or assumed, the pipe size may be established.

The pressure drop is not necessary in the first determination of the proper size of pipe. The size will affect the amount of drop, and the latter should be calculated after the size has been determined to see whether or not it is excessive.

The degree of superheat will affect the pipe size insofar as it affects the specific volume. As the relation between the degree of superheat and the specific volume follows no simple law, it is not possible to incorporate it in these charts. When superheat is present, the specific volume must first be taken from a steam table and the chart used as given here.

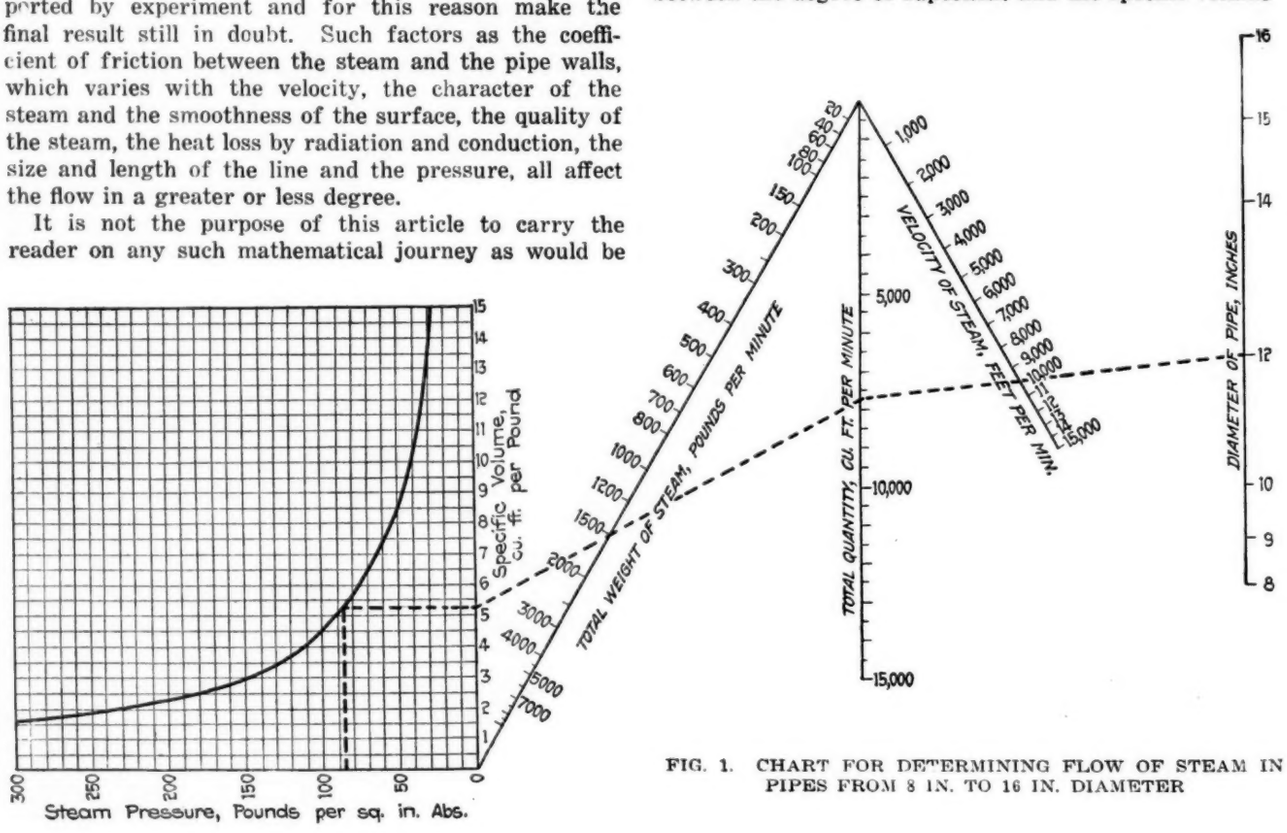

Specific Volume, Cu. Ft. per Pound
Steam Pressure, Pounds per sq. in. Abs.
TOTAL WEIGHT OF STEAM, POUNDS PER MINUTE
VELOCITY OF STEAM, FEET PER MIN.
TOTAL QUANTITY, CU. FT. PER MINUTE
DIAMETER OF PIPE, INCHES

FIG. 1. CHART FOR DETERMINING FLOW OF STEAM IN PIPES FROM 8 IN. TO 16 IN. DIAMETER

The theory involved is simple and may be expressed in the following manner,

$$Q = AV = \frac{0.785\ D^2\ V}{144} = 0.00545\ D^2\ V \qquad (1)$$

in which equation

Q = Quantity of steam flowing in pipe in cubic feet per minute;
A = Area of pipe in square feet;
V = Velocity of steam in pipe in feet per minute;
D = Diameter of pipe in inches.

With this formula it would be necessary to know not

only the velocity desired, but also the quantity flowing in actual cubic feet. This latter factor is seldom known directly and must be determined before this equation can be applied. This may be done as follows:

$$Q = WV' \qquad (2)$$

in which,

Q = Quantity in cubic feet per minute as before;

W = Weight of steam flowing in pounds per minute;

V' = Specific volume of steam in cubic feet per pound.

From the foregoing it will readily be apparent that one may combine equations (1) and (2), eliminating Q. The other factors must either be known or assumed before the diameter can be determined. The value of W is usually known; if not, there is no problem to solve. The specific volume can be found quickly by turning to the given pressure in the steam table. The velocity that is to be allowed must be assumed. If the size of pipe comes too high, a greater velocity must be taken because the other factors are seldom flexible. With this information at hand the two equations may be solved and the pipe size determined. In the same manner any one of the other variables may be solved if the diameter of pipe is first known.

The graphical chart shown in Fig. 1 quickly and accurately solves these two equations. At the left of the chart a pressure-specific volume curve has been incorporated which makes the whole complete. It is then not necessary to use a steam table with this chart when dry steam is under consideration. The dash-dot line across the chart shows the method of use. In this chart it was assumed that the pressure was known to be at 85 lb. absolute or 70 lb. gage. At this pressure the curve shows that the volume is about 5.25 cu.ft. The total weight of steam which it is desired to have pass through the pipe per minute has been taken at 1,500 and the allowable velocity at 10,000 ft. per min. To determine the size of pipe required to accomplish this, it is merely necessary to connect the volume with the weight and continue the line until it meets the quantity scale. We may not be interested in the actual number of cubic feet of steam which is flowing per minute, but if we are it may be read from this scale and in this case is found to be 7.750. This point in turn is connected through the 10,000 point on the velocity scale with the diameter scale. It is seen that a pipe 12 in. in diameter will carry the required weight of steam at the desired velocity.

The reverse of this problem many times comes up for solution, and here again the chart will apply. For example, suppose it is required to find the velocity of steam flow in a 10-in. line carrying 1,000 lb. of steam per minute and a pressure on the line of 200 lb. per sq.in. absolute. If the reader will connect the point on the specific-volume scale which corresponds to the given pressure, in this case about 2.25, with the 1,000 point on the diagonal representing the weight scale and then from the point on the quantity scale which is cut out by producing this line, draw to the 10-in. position, it will be found that this latter line will cut out on the velocity scale the value of 4,200, which is about the velocity obtained. If he will go through this simple example, he will note quickly how the chart is used.

In the same manner any one of the six variables incorporated may be determined quickly and with sufficient accuracy for practical work. Special problems often arise in steam work, making it necessary to solve any one of the variables given on the chart.

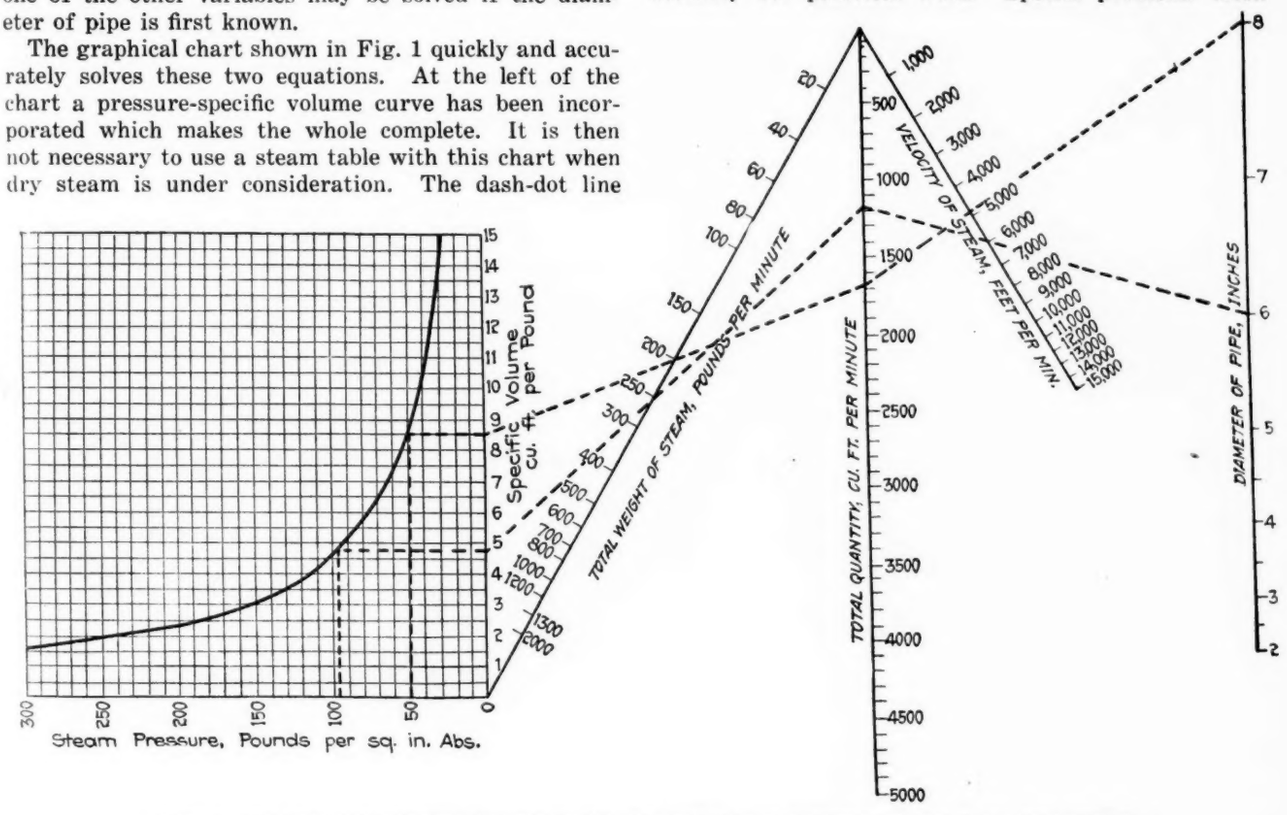

Specific Volume cu. ft. per Pound
Steam Pressure, Pounds per sq. in. Abs.
TOTAL WEIGHT OF STEAM, POUNDS PER MINUTE
VELOCITY OF STEAM, FEET PER MIN.
TOTAL QUANTITY, CU. FT. PER MINUTE
DIAMETER OF PIPE, INCHES

FIG. 2. CHART FOR DETERMINING FLOW OF STEAM IN PIPES 2 IN. TO 8 IN. DIAMETER

The range of the variables as given on the chart in Fig. 1 is that generally met with in steam practice. Later, it will be shown how this chart was designed so that the reader may construct one for himself with any limits for the variables which may suit his special needs. It will be observed at once that the diameter scale begins with an 8-in. pipe. It was found impractical to incorporate lower values and still maintain accuracy in the other scales.

In using this chart, it must be remembered that the pressure is plotted as absolute pressure, and when the gage pressure is known or desired, 14.7 lb. must be

taken from the value given on the scale. These pressures and volumes are plotted as given in the steam tables, so that the user would have no trouble if he had to take the value from the tables instead of the curve. This procedure might be desirable when greater accuracy was desired or necessary if superheat were present. Wet steam also will affect the specific volume, and if much water is present it will be well to take the volume from the curve for dry steam and then multiply the percentage of steam by this value, which will give the true volume. This latter value may then be found on the scale and the chart used in the usual way. This procedure neglects the volume of water present, but as this is usually small, it may be neglected without introducing an appreciable error.

It has already been stated that it was not found practicable to carry the pipe sizes below 8 in. on the chart shown in Fig. 1. As a large percentage of steam work involves sizes below this, it was deemed advisable to construct a second chart with the lower values. Such a chart is given in Fig. 2. The theory and principles involved here are the same as for Fig. 1, excepting for the limits of the variables. These limits are in keeping with smaller pipes.

Two illustrations of how to use the chart given in Fig. 2 are shown by the dash-dot lines. In one case a pressure of 50 lb. has been assumed, together with a weight of steam of 200 lb. per min. and a pipe of 8 in. By tracing the dash-dot line the reader can see that the steam velocity will be about 4,900 ft. per min. and the quantity flowing about 1,680 cu.ft. per min. In the other chart the pipe size and velocity are taken respectively at 6 in. and 6,000 ft. per min. and the weight flowing at 250 lb. per min. By tracing the line through, it will be observed that the quantity is about 1,180 cu.ft. per min. and the specific volume 4.75. This represents

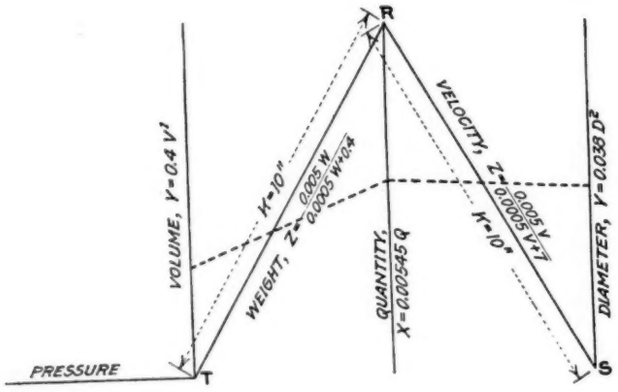


FIG. 1-A. CHART ASSISTS IN FINDING VALUE OF K WHEN LAYING OUT CHARTS SUCH AS SHOWN IN FIG. 1

a pressure of about 97 lb. abs. or 82 lb. gage. This means that this much pressure must be maintained on the 6-in. line if the desired quantity and weight is to be put through at the velocity of 6,000 ft. per min.

These two charts when used together cover the ordinary range met with in everyday practice. The limits in all cases have been chosen with the view of reaching all possible extremes. Sizes larger than 16 in. are met so seldom that it is not believed worth while to build up such a chart for the larger values. This could be readily carried out, however, and a method will be pointed out later by means of which the reader may construct such a chart for himself if his work warrants the time involved.

It has been the writer's experience in observing the work and study of fellow engineers that when a reader notes something in the chart line in an up-to-date journal, he often takes the attitude that although it is of value to him it is of little use on the page of the magazine. No means are usually available for reproducing it on a separate sheet, and so he lets it go by without so much as making a reference in his notebook so as to

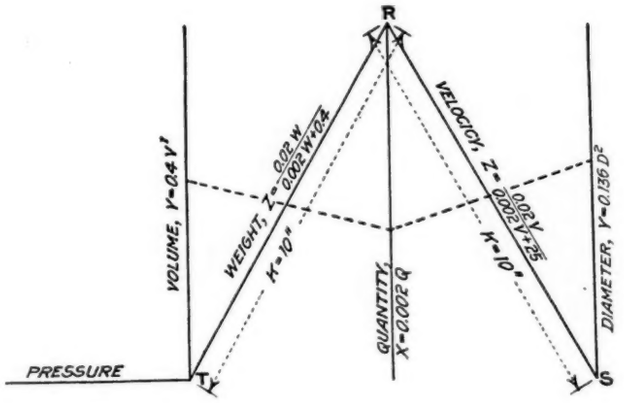


FIG. 2-A. CHART FOR DETERMINING CONSTANTS FOR LAYING OUT CHARTS AS FIG. 2

be able to find the chart later if needed. Usually, it is necessary to reduce these graphs to such an extent that accuracy is seriously impaired. The reader knows this and decides that it would be of little use to him in that form. Charts of this kind reach many readers through the libraries. These readers do not have a copy of the journal themselves, and the effort necessary to send specially for one copy is sufficient to make them decide that they do not want the article or the charts badly enough for that.

For these reasons the writer believes it good policy to include in such an article as this enough of the theory and sufficient explanation of the charts to enable the reader to construct them. No attempt will be made to include unnecessary theory or to derive the fundamental formulas involved. For the truth of these the reader may check them up by substituting values.

Let us start with the chart Fig. 1. This chart is known as the Z because its shape resembles that letter. We have here a combination Z because the principle has actually been applied twice. Fig. 1A gives a diagram of the scales and on each one of these lines is written an equation. This is the equation of the scale and means that the position of each one of the values shown on the scale in Fig. 1 is determined by this equation. It will be noticed that the equation in each case contains but two variables, the one representing a quantity in the formula being charted and the other the distance of a given value from the origin which is the point where the scales meet, or the corner, of the Z.

The foregoing may be a bit technical and perhaps not quite clear. Let us take the actual formula charted in Fig. 1. The first part of this is given in Equation (1) and was as follows:

$$Q = AV = 0.00545\ D^2\ V$$

We have here a simple three variable equation connecting the three quantities Q, D and V. The first thing to

do is to select the limits of these quantities. Decide the maximum value of Q, D and V which you desire to have on the chart. This is usually regulated by practice. The chart should be made to cover the useful range of the variables. When this has been done, the equations of the scales may be written as follows:

$$X = m_1 Q, \qquad Y = m_2 (0.00545\ D^2), \qquad Z = \frac{K\ m_1\ V}{m_1 V + m_2}$$

It now becomes necessary to select values for the constants m_1, m_2 and K. These are determined by the actual size of chart which is to be constructed. The value of K will be the length of the diagonal of the Z in inches. This is shown in Fig. 1A, and in the chart Fig. 1 has been taken at 10 in. Any other value may be used as found convenient. The values of m_1 and m_2 are somewhat dependent on the value of K selected, as one would not like to have these scales extend far out beyond the junction points with the diagonal. It makes a good appearance to have the side scales come about even with the ends of the diagonal. With the maximum value of Q and D in mind as selected above, it is simple to determine m_1 and m_2. Let us suppose we limit the length of the Q scale to 7.5 in., as has been done in Fig. 1. Then if we substitute in $X = m_1 Q$ the values of $X = 7.5$ and $Q = 15{,}000$, we find that $m_1 = 0.0005$ and the equation of this scale becomes $X = 0.0005Q$. With this equation of the scale it is easy to lay off the actual scale. Merely substitute various values of Q from zero up to the maximum value of 15,000 in this case into this formula and obtain the corresponding value of X. This value of X will be in inches and represents the actual distance from the starting point. These distances may then be laid off from the point R, as given in Fig. 1A. Each point must be marked with its corresponding value of Q. This process is quickly accomplished when the equation is as simple as the one for this variable Q.

The value of m_2 for the D equation is determined in the same manner except that here we have a constant to deal with in the form of 0.00545 and also a squared term. Neither of these should cause any trouble. The maximum value of D has been determined, and if the maximum length of the scale is selected which represents the value of Y, we can nicely calculate m_2. It may be found that the value of m_2 becomes an odd figure if the length of scale is selected in even inches. It is usually better practice to select the modulus, as m_2 is called, an even number and let the scale come an odd length. If this is kept in mind, it will save time in putting in the scales. For the chart shown the value of m_2 was taken at 7, which makes the final equation for the D scale read as follows:

$$Y = 7\ (0.00545\ D^2) = 0.038\ D^2$$

The Y scale may then be laid in by measuring off from the point S the values of Y obtained from this equation when various values of D are substituted. Each point should be marked with its own value of D.

The diagonal scale is somewhat more complicated and requires a little more calculation in the determination of the points. The equation of the scale involves m_1, m_2 and K and therefore is entirely dependent on these values as selected for the two previous scales. It is therefore highly important that the equations of all three scales be determined before any are drawn in. It is often found that the values selected will not give a good scale for the diagonal. It may be too long or so short that all accuracy is lost. In either event the calculation must be gone through with again and more suitable values selected. It may be necessary to change the value of K. It will be noticed that V varies directly as K and therefore a change in this constant has more effect than the others. With the values selected above this diagonal equation becomes

$$V = \frac{K\ m_1\ V}{m_1 V + m_2} = \frac{10\ (0.0005\ V)}{0.0005\ V + 7} = \frac{0.005\ V}{0.0005\ V + 7}$$

The various values of V must be substituted in this equation and the corresponding values of Z determined. This equation can be nicely solved on the slide rule and it is not as long a job as might at first appear. These values of Z thus determined should be laid off along the diagonal from the point R. Each point must be marked with its own value of V.

This completes the first part of the problem. A straight-edge laid across the scales will solve equation (1). Any two of the variables being known, the other may be quickly found in this way. Fig. 1 shows a value of $D = 12$ in. connected through a value of $V = 10{,}000$ ft. per min. The quantity flowing is shown on the Q scale to be 7,500 cu.ft.

The left-hand part of the chart is a duplicate of the first part in regard to the principle involved. We have here another Z chart turned the other way around and one of its scales coinciding with one of the scales of the first chart. This was made possible because the value of Q appeared in both formulas. It will be recalled that equation (2) was as follows:

$$Q = WV'$$

If we make the modulus of the Q scale in both of these charts the same, they may be placed upon one another. These equations of scales were obtained as shown above and are as follows:

$$X = m_1 Q, \qquad Y = m_2 V', \qquad Z = \frac{K\ m_1\ W}{m_1 W + m_2}$$

The values of the constants selected follow: $m_1 = 0.0005$, $m_2 = 0.4$ and $K = 10$. It is not necessary that K be the same as selected for the other chart. It was selected the same in this case to make a more balanced chart. The equations of the scales then becomes

$$X = 0.0005\ Q, \qquad Y = 0.4\ V', \qquad Z = \frac{10\ (0.0005\ W)}{0.0005\ W + 0.4} = \frac{0.005\ W}{0.0005\ W + 0.4}$$

The scales may now be laid out as in the previous case. Only two remain, as the Q scale is already in place. The same rule applies here, however, as stated; that is, it is not advisable to put in any of the scales until the equations for the whole chart have been determined. The moduli many times have to be juggled to make a good appearing and useful chart. An illustration of this is found in the two given here. It was not found practicable to extend the D scale beyond the value of 8 in Fig. 1. It was necessary to carry it further in a second chart.

A chart should always be complete in itself; that is, it should be possible to solve completely the problem for which the chart was designed with the data usually available. With this chart thus far designed, this would not be possible, as the specific volume of the steam under consideration is seldom known directly and must be looked up in a steam table. Usually, the pressure is known instead. To make the chart complete, there has been added a pressure-specific volume curve at the left. Such a curve may be plotted as shown by taking from the steam tables the values of V' corre-

sponding to the various pressures. This is merely a simple curve and may be plotted on thin cross-section paper. The V' scale on the plot must coincide exactly with the V' scale on the chart. The value of m_2 for this scale must be selected with this in view.

The chart shown in Fig. 2 is built up for the same formulas as the one shown in Fig. 1, but for different values of the variables. This chart applies to large pipe. The theory is the same as given above except for the actual values of the modulus selected. To enable the reader to reproduce this chart himself, the equations of the scales will be given. For the first part, which is represented by the right-hand part of the chart and the equation $Q = 0.00545\ D^2\ V$, we have:

$X = m_1\ Q = 0.002\ Q,$

$Y = m_2\ 0.00545\ D^2 = 25\ (0.00545\ D^2) = 0.136\ D^2$

$$Z = \frac{K\ m_1\ V}{m_1 V + m_2} = \frac{10\ (0.002\ V)}{0.002\ V + 25} = \frac{0.02\ V}{0.002\ V + 25}$$

The equations of the second part shown at the left and representing the question $Q = WV'$ are as follows:

$X = m_1 Q = 0.002\ Q,$

$Y = m_2 V' = 0.4\ V',$

$K = 10$ inches,

$$Z = \frac{10\ (0.002\ W)}{0.002\ W + 0.4} = \frac{0.02\ W}{0.002\ W + 0.4}$$

The manner of laying out this chart is shown in Fig. 2A. For convenience the equations of the various scales are written thereon. With the foregoing explanations the reader should have no trouble in reproducing both these charts. If a smaller size is desired, it can be obtained by changing the values of the constants, m_1, m_2 and K. The theory outlined must be followed to make the chart solve the formula when finished.

The quickest and perhaps the most satisfactory way to draw these charts is to draw them in pencil directly on tracing cloth. When finished, they may be quickly inked and blueprinted. The plotted curve at the left may be drawn on a piece of cross-section paper and pasted to the tracing cloth. Care should be exercised to make the V' scale exactly coincide on the two drawings. The charts will be found to be time savers by designers who constantly have occasion to determine pipe sizes and steam velocities. In a subsequent article the writer will take up a more simplified form of chart that may be employed when the cubic feet of steam does not enter the problem.

Electric Power in the Arctic Regions

One would hardly associate electric power stations with the snowbound Arctic regions, yet, despite the intense cold and six months of ice and snow each year, a number of hydro-electric and steam-turbine plants have been erected during the last fifteen years for the purpose of garnering the rich deposits of gold in the bed of the Yukon River.

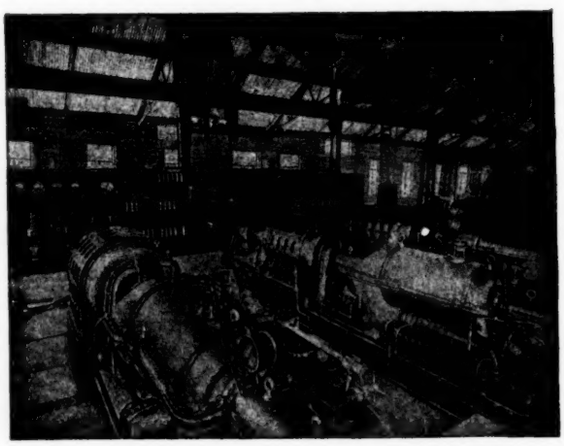
Over twenty-five million dollars has been expended by large operators for the furtherance of these projects. Miles of ditches have been excavated, powerful hydraulics installed and hydro-electric and steam-turbine plants constructed. This was no easy task. It meant fighting weather sometimes seventy degrees below zero and working on ground frozen to a depth of thirty feet. Moreover, heavy machinery and equipment necessary to carry on the work had to be transported over two thousand miles of wilderness.

Among the first of these operators was the Yukon Gold Co., which in 1905 installed, a few miles above Dawson, a hydro-electric plant of 1,875 kw., operating under a 650-ft. head. The plant consisted of three 54-in. Pelton waterwheels, each direct-connected to a 625-kw. 2,200-volt three-phase 60-cycle Westinghouse generator. The company had 36 miles of main-line transmission and 18 miles of branches and supplied energy for nine electric dredges, each using from 300 to 500 horsepower.

The Canadian Klondyke Co., shortly after, began operations about 26 miles above Dawson with the installation of a 10,000-hp. hydro-electric plant equipment consisting of two 3,000-kva. 2,300-volt 60 cycle three-phase generators, direct-connected to 5,000-hp. I. P. Morris Francis reactionary turbine wheels. Two banks of transformers stepped up the voltage from 2,300 to 33,000.

This plant was located farther north than that of the Yukon Gold Co., and it was found necessary to install electric heaters at the intake and at intervals of about two miles in its six-mile power ditch and also in the receiving chamber at the penstock heads to keep the anchor ice thawed out.

About thirty-five miles down the Yukon from Dawson the Northwestern Light, Power and Coal Co. located a 10,000-hp. steam-turbine station. Much of the equipment for this plant was shipped by the British West-

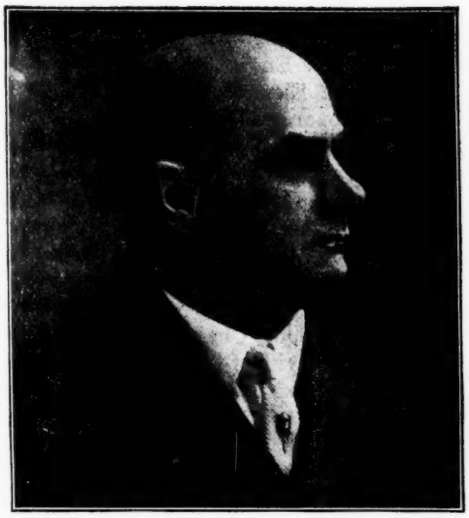


TEN THOUSAND HORSEPOWER STEAM-TURBINE PLANT, COAL CREEK, ALASKA

inghouse Co., from Manchester, England, across Mexico, to the Pacific and thence by water and rail 1,000 miles down the Yukon, where it was taken over the 600-mile snow trail in winter. The plant was finally installed at a cost of $2,500,000, but operated only 100 days when it was shut down because of legal difficulties and lack of coal. The machinery and equipment were not allowed to fall into disuse, but were dismantled and shipped to Japan, where they are used to furnish power for the operation of paper mills.

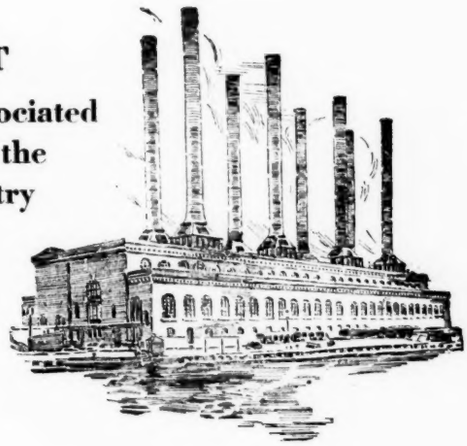
These electric stations, located practically on the Arctic Circle, represent 25,000 hp. of generating equipment and 10,000 hp. of auxiliary apparatus. At times the plants have been overloaded and the service requirements were very heavy, but they have run continuously and without serious trouble since their installation. During the fifteen years of operation over one hundred and fifty million dollars' worth of gold has been taken from the Yukon.

A Leader in Power-Plant Operation



W. L. ABBOTT

Thirty-five Years Associated with Progress of the Electrical Industry



A hard worker, day in and day out, a prodigious memory, tact, an even temperament, ability to judge men, gain their confidence by considerate treatment and get from them maximum returns to the limit of their ability, are the leading characteristics that have guided Mr. Abbott along a career of uniform success in the lighting industry. Having a happy combination of technical and practical knowledge, coupled with an analytical mind, he is quick to grasp essentials, to detect inaccuracies and to see at a glance the merits or flaws in reports submitted to him. "Information is only of value when it is correct" is a favorite expression used diplomatically to point out an error. As an operating man and later a director of operation, Mr. Abbott has few equals.

"FOLLOW the gleam!" is advice often given to ambitious and aspiring youth. W. L. Abbott, the subject of this sketch, has followed the gleam, not only in a metaphorical sense but quite literally, for he was one of the first engineers in Chicago to cast his lot with the electric light. He has followed it perseveringly and consistently for thirty-five years and has participated in its triumphs and the triumphs of its close associates, electric heat and electric power. He has been diligent in this business and has made an enviable reputation.

William Lamont Abbott is a native of Illinois and was born Feb. 14, 1861, near Morrison, in Whiteside County. He was graduated from the University of Illinois in 1884, having taken the four-year course in mechanical engineering. Twenty-one years later his Alma Mater granted him a master's degree.

Coming to Chicago (which has been his home ever since) after his graduation from college, Mr. Abbott was early impressed with the possibilities of electrical development. Electric lighting was then truly "in its infancy," but young Abbott was discerning enough to think it *had* a future. Accordingly, in 1885, with F. A. Wunder, he organized the Wunder & Abbott Illuminating Co. This company supplied arc lighting service in the central business district of Chicago, later absorbing several smaller companies engaged in similar work. In 1887 the Chicago Arc Light and Power Co., later absorbed into the Chicago Edison Co., one of the predecessors of the present Commonwealth Edison Co., was organized, and Mr. Abbott disposed of his interests in the Wunder & Abbott Co. to this corporation.

In 1888 Mr. Abbott, with others, organized the National Electric Construction Co., with himself as president and general manager. This company did general electrical construction work and also engaged in electric lighting in Chicago. Gradually, Mr. Abbott acquired the interests of his associates, conducting the affairs of the company until 1894. In that year the company was purchased by the Chicago Edison Co., Mr. Abbott continuing to manage the construction work of the company for another year, during which time he was also the assignee of the Northwestern Light and Power Company.

In 1895 the business of the National Electric Construction Co. was completely absorbed by the Chicago Edison Co. and Mr. Abbott was appointed chief engineer of the then New Harrison Street generating station of the Chicago Edison Co. It was not long before he knew his station thoroughly, and he made it his business to know everything that was going on in it. One of his favorite customs was to come down on Sundays, review with department heads the work of the past week and plan for the week to come. Under his direction the station became the most economical plant of its day. It was here that alternating-current generation and distribution, as we know it today, was given its first impetus. The station became familiarly known as the laboratory of the electrical industry, due to the amount of research work done there.

Mr. Abbott early realized that the great opportunity for saving lay in the boiler room. He had conspicuous ability to surround himself with and use capable men. Among those on his staff at different times were Walter T. Ray, C. H. McClure and A. Bement. Under his direction these men conducted extensive experimental investigations relating to the economical burning of coal. Innumerable tests on the various grades and sizes of coal were conducted to determine the burning qualities of each, analyses of coal and the gases of combustion were made practical and there was long-continued investigation on the placing and arrangement of baffles. The work at this station originated the inspiration for the general development in the boiler room that has now become so well established. Manufacturers and others in the industry profited from the results obtained, so that few people realize the extent of the influence from these pioneer investigations.

In reviewing this work, mention should be made of an extended research on the discharge of water with steam from water-tube boilers. The results, as presented by A. Bement, were given wide publicity in the technical press of Great Britain and this country. One of the things done at the Harrison Street station, in which Mr. Abbott takes particular pride, was the development of a method to determine the variation in angular speed during one revolution in the big triple-compound engine-driven alternators installed at the station, such variations being responsible for cross-currents when operating in parallel. It was first necessary to get the mean rotative effort of the three steam cylinders and plot against this the effects of inertia. The resultant gave the actual variation, which was found to be within permissible limits.

In May, 1899, Mr. Abbott was appointed chief operating enginer of the Chicago Edison Co., later the Commonwealth Edison Co., of which he is chief operating engineer at the present time. His position is one of much responsibility, for he has supervision, under Vice President L. A. Ferguson, of the generating stations, substations, load dispatchers, street department, storage batteries, meter department, service and repair department and lamp renewals of an electricity-supply organization which had an output of 1,628,340,000 kw.-hr. in 1919. The chief operating engineer is active in company affairs, being vice chairman of the important Advisory Committee, manager of the Edison Symphony Orchestra, etc.

One of his hobbies has always been to do something for the employees. At Harrison Street he started a night school to give members of the force instruction in steam and electrical engineering. At about the same time he also formed an employee's aid association, with sick and death benefits. This association died with Harrison Street, but recently Mr. Abbott originated a similar movement for the employees of the entire company, which at this writing is on the point of going through.

A loyal son of his state and always interested in higher education, Mr. Abbott was put forward by the alumni of the University of Illinois in 1904 as a candidate for the office of trustee of the university. He was elected by the people and reëlected in 1910 and in 1916. For twelve years of this period Mr. Abbott served as president of the board of trustees of the university, retiring last year (1919) as president, but still remaining a member of the board. On Nov. 4, 1916, a testimonial dinner was given in his honor at the Hotel LaSalle, Chicago, in recognition of his years of loyal service for the university.

A busy man, Mr. Abbott has found time to coöperate in the activities of professional societies and civic organizations. He served as president of the Western Society of Engineers in 1907. He is a member and a former chairman of the Chicago section of the American Society of Mechanical Engineers and a fellow of the American Institute of Electrical Engineers. He is also a member of the honorary engineering fraternity Tau Beta Pi, of the honorary scientific society Sigma Xi and an honorary member of the National Association of Stationary Engineers. He belongs to the Chicago Athletic, University, Engineers and Electric clubs of Chicago and the Chicago Association of Commerce.

Numerous papers on technical and other subjects have been presented by Mr. Abbott before various societies. In 1906 his paper entitled "Some Characteristics of Coal as Affecting Performance with Steam Boilers," read before the Western Society of Engineers, was awarded the Chanute medal.

As an expert in the buying, handling and storage of coal Mr. Abbott has been especially prominent, and necessarily so, as he is engaged by a company now spending seven million dollars a year for its fuel and storing up to five hundred thousand tons of coal. His early testing experience at Harrison Street gave him an intimate knowledge of the values of coal. From long study he has found that the coal to store is egg, 1½ to 6 in. Larger lumps tend to break up in handling, and spontaneous combustion will develop in the finer coal. Between the sizes specified coal has been stored at all seasons of the year with practically no trouble from fires.

During the war Mr. Abbott gave freely of his time and effort in his country's cause, serving on several committees and boards having to do with recruiting activity or other wartime necessities. At present he is chairman of the executive committee of the Bureau for Returning Soldiers, Sailors and Marines. His son, Capt. Arthur Abbott, also had a creditable war record.

One of Mr. Abbott's valuable possessions is a sense of humor. He is philosophical and accomplishes a great deal of work without much apparent effort. In conference his opinion carries weight and is received with no less attention because it may be accompanied by some quizzical or playful remark that may serve to create a bright spot in the discussion.

Hydro-Electric Power in Canada

Canadian water power is being developed as rapidly as possible, according to facts and figures given out by the Dominion Water Power Branch, Department of the Interior, and the Dominion Bureau of Statistics, which, with the coöperation of the Department of Trade and Commerce, has just completed a census of the developed water power in the Dominion. These figures include development up to January, 1920, and show that throughout Canada approximately 2,418,000 hp. has been made available. Many of the plants now in operation were designed for the addition of further units, which will bring their ultimate capacity, together with several new plants under construction, up to 3,385,000 hp. Hydro-electric power that can be made available in the British Empire totals from fifty to seventy million horsepower. It is calculated that Canada contributes in the neighborhood of twenty million horsepower to this total.

Refrigeration Study Course—VIII. Low-Temperature Ammonia Compression

By H. J. MACINTIRE
Professor Mechanical Engineering, University of Idaho

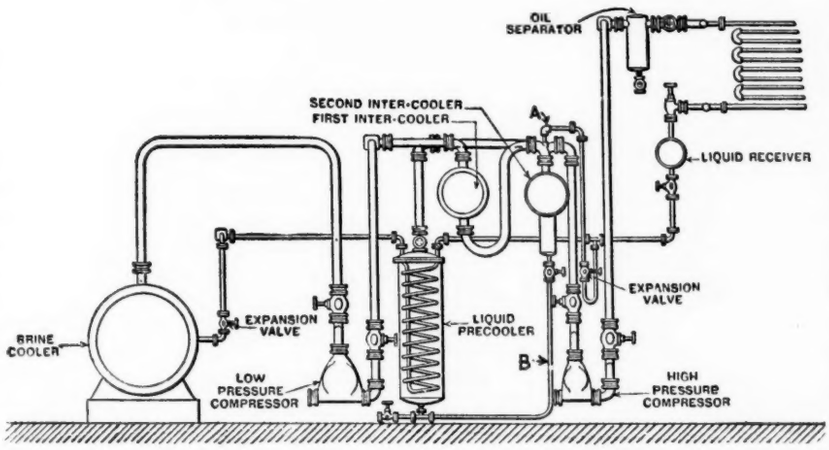
CERTAIN applications of refrigeration require low temperatures, the production of which adds to the difficulties and the operating problems of the engineer. These low temperatures are found in cold-storage work, possibly ice-cream hardening, in oil refining and in special chemical industries of various sorts. In these applications of refrigeration, temperatures of zero deg. Fahrenheit or lower are maintained, thus requiring minus 15 deg. F. or lower boiling temperature of the ammonia.

At low boiling temperatures the ammonia compressor of the standard design is not efficient except at very low head pressures. At normal condenser pressures the standard machine has the following capacities per ton, 20 lb. suction and 175 head pressure taken as unity: Suction pressure, 40 lb., 1.611 tons; 30 lb., 1.306 tons; 20 lb., 1 ton; 10 lb., 0.6993 ton; 0 lb., 0.4101 ton; —5 lb., 0.263 ton.

From this it is seen that at low suction pressures the standard compressor fails as a medium for securing refrigerating duty, and the engineer sees clearly why the manufacturers designate the operating conditions; namely, 175 head pressure and 15.2 lb. suction gage pressure. In the figures given a 100-ton machine has only 26.3 tons capacity at minus 5 lb. suction pressure.

The reasons for lowered capacity with decrease of suction pressure have already been brought out in this study course; but it is worth while making mention of them again at this time. These reasons are on account of the low density of the ammonia at low pressures, the small volumetric efficiency obtainable, and finally, the trouble in the condenser by overheating the ammonia.

Some operating engineers have no clear idea of the so-called density and its effect on the tonnage of the machine. Yet in the use of steam they see clearly the reason for the relative increase in size of the exhaust-steam pipe as compared with the inlet boiler steam, especially when a low vacuum is carried



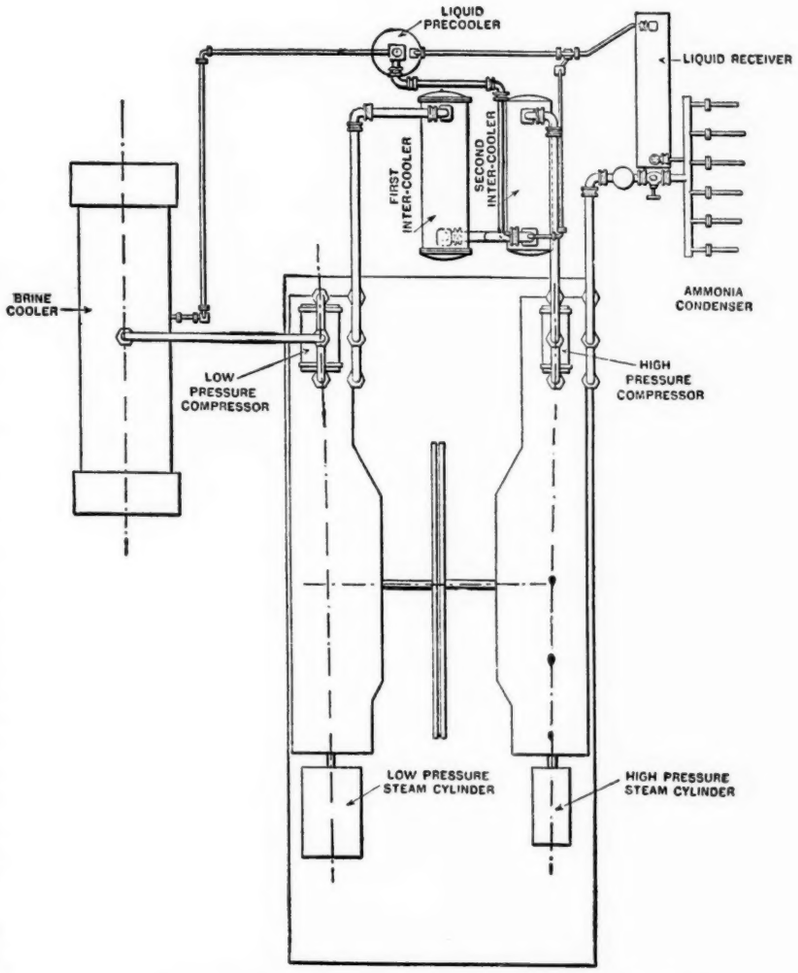


FIG. 1. PLAN AND ELEVATION VIEWS OF A LOW-TEMPERATURE COMPRESSION SYSTEM, SHOWING THE IMPORTANT CONNECTIONS

as is true with the turbine operating condensing. In the steam engine or turbine the same weight of steam is exhausted as enters from the steam header, but the pressure is much lower. We say under these conditions that the *volume* of a unit weight of steam (one pound) is much greater with the lowered pressure. It is like the bicycle or auto air pump which compresses the air in the cylinder to a lower volume, but which has the same *weight* of air in the cylinder under both conditions.

The density of saturated ammonia, then, is less as the pressure is reduced, as may be seen from the following approximate values:

Gage Pressure, Lb.	Cubic Feet per Pound
20	8.0
15	9.3
10	11.0
5	12.9
0	17.9
5	24.1

The ammonia compressor, which has a fixed piston displacement per stroke, will pump the same number of cubic feet of ammonia per minute, but will have fewer and fewer pounds of ammonia discharged out of the compressor as the pressure is lowered. And the tonnage is always proportional to the amount of ammonia *in pounds* which is pumped into the condenser per unit of time, usually taken in minutes.

The volumetric efficiency has to be considered because of the reëxpansion of the gas in the clearance space at the beginning of the suction stroke. This reëpansion prevents the inlet valve from opening until the gas in the clearance volume has been reduced at least to the suction pressure. Under conditions of operation prevailing in low-temperature operation, this reëxpansion factor looms up in large proportions and materially affects the effective stroke. Clearance reëxpansion is not a direct cause of increasing the power required to compress and pump a given amount of gas, but it cuts down the capacity of the machine, as the cylinder is supplied by much less than the full cylinder volume of gas per stroke.

The third objectional feature of single-stage compression as applied to ammonia is in the high temperature of discharge of the gas. In air compression the rule is usually to pump from atmosphere to about 70 lb. in the first stage and from 70 lb. in the first stage and from this pressure to the required pressure when moderate final pressures are required. An intercooler is placed between the stages, and the gas is cooled to within a few degrees of the available cooling water before passing on to the second stage. The reason for so doing is to increase the volumetric efficiency, decrease the work of compression and prevent excessive discharge temperatures.

Excessive discharge temperatures are bad for ammonia. Considerable difference of opinion has been expressed on the subject, but it is clear from the practical experience of refrigerating engineers that high discharge temperatures, as well as high head pressures, tend to disintegrate the ammonia into hydrogen and nitrogen. These gases are permanent, and they collect in the condenser and, unless purged, will gradually increase the head pressure, like the manner of the increase in the condenser pressure when the air pump is stopped in the case of the steam engine or turbine. The formation of inert gases in the condenser has resulted in excessive purging and heavy losses of ammonia which invariably passes out of the condenser during the purging process.

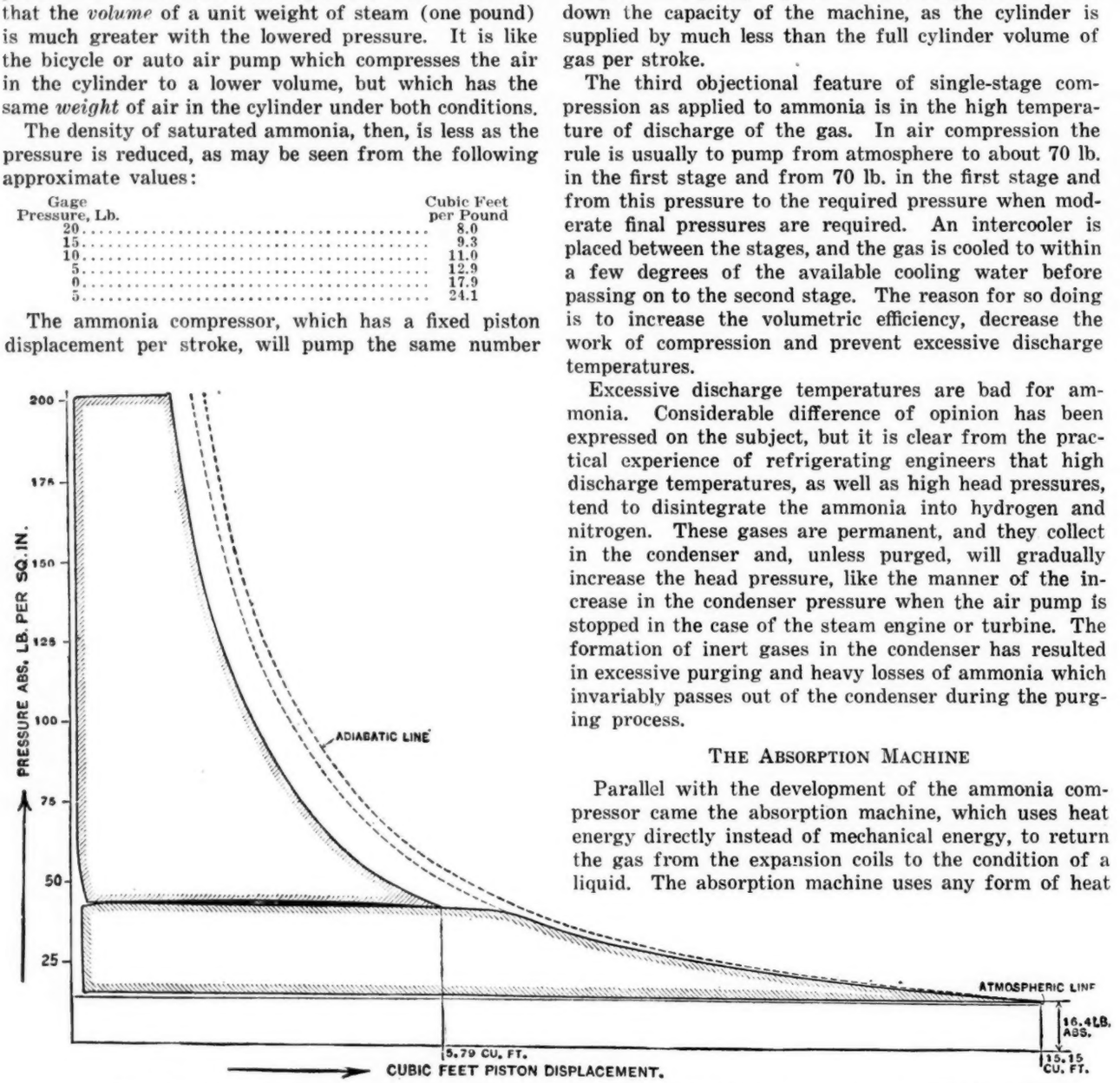


FIG. 2. THE COMPRESSION LINE IS BROKEN IN COMPOUND COMPRESSION BY REASON OF INTERCOOLING THE AMMONIA GAS BETWEEN THE LOW AND THE HIGH PRESSURE CYLINDERS

The discharge gas first passes through an intercooler where water is the cooling medium. It then passes through one where liquid ammonia is the cooling agent.

The Absorption Machine

Parallel with the development of the ammonia compressor came the absorption machine, which uses heat energy directly instead of mechanical energy, to return the gas from the expansion coils to the condition of a liquid. The absorption machine uses any form of heat energy, but at present exhaust steam is most used. No compressor is required, but only a liquid pump of relatively small size. The result is that low boiling temperatures of the ammonia may be readily and economically obtained, requiring about 30 lb. of steam for 10-deg. brine and 34 lb. of steam for —10-deg. brine, calculated for 60 deg. cooling water.

The absorption machine has never seen much popularity even at the best time of its career. It is large, costly, awkward and more difficult to operate successfully than the compressor. Steam must be available. When operated by competent engineers, it is satisfactory and can achieve low temperatures with ease. Until

the perfection of the compound ammonia compressor, it was used for all low-temperature refrigeration.

Compound ammonia compression for low-temperature refrigeration has a number of important features. It is stage compression, with an intercooler between stages. It is possible to arrange the suction of the high pressure so that it will take care of the gas from the freezer rooms, but this multiple effect suction is not popular. It is more advantageous to design in a manner similar to the compound steam engine, and to try to equalize the load due to compression between the two cylinders. Thus, instead of using a receiver pressure of 25 to 30 lb. gage, a pressure of some 45 to 55 lb. would have to be used, depending on the head pressure and suction pressure.

As we all know, compound compression requires an intercooler as well as an aftercooler (the condenser in refrigeration). In air, or ordinary gas compression, water is used in the intercooler, but this is not possible with ammonia because the temperature of saturation at 45 and 55 lb. gage is 30 deg. F. and 38 deg. F. respectively. It is evident that water may not be used for such cooling, unless the intercooler used water for the first part of the process and finished by means of some other cooling medium similar to the Bandalot cooler principle. The only convenient and natural medium for such low-temperature intercooling is expanded ammonia. This is done by means of an accumulator arrangement.

The functions of the accumulator are twofold. It will be remembered that under usual circumstances there is some 10 to 15 per cent of ammonia vaporized at the expansion valve to cool the remaining liquid ammonia from the temperature of the liquid receiver to that of the temperature of evaporation (boiling) in the expansion coils. The vapor formed in the process cannot be used for refrigeration, but clogs up the expansion system unless removed. The gas formed increases in amount in cases of extreme pressure range, as in the case where low-temperature refrigeration is required, and so the accumulator principle is used to remove the gas formed in precooling and to remove the superheat from the discharge gas from the low-pressure cylinder.

Fig. 1 shows the general arrangement of the cylinders and intercoolers. Referring to the figure, it will be seen that the gas discharged from the low-pressure cylinder is made to go through the water-cooled first intercooler and then through the ammonia-cooled second intercooler. The discharge gas is thereby cooled from, say, 100 or 150 deg. F. to about 35 deg. F. and some five per cent (perhaps) of liquid ammonia is vaporized in the process. Liquid ammonia not vaporized after passing into the second intercooler through the valve *A* flows by gravity down pipe *B* into the liquid precooler which is open at the top of the intercooler receivers, and the gasified ammonia passes out and enters the high-pressure cylinder of the compressor. The liquid from the liquid receivers, having passed through a long coil in contact with boiling ammonia, will be precooled to about 30 to 35 deg. F.

What is the advantage of all this? It seems that a lot of extra piping has been designed all to no purpose, as the same things occur anyway. Yet this is not true, as can be seen on careful consideration of the conditions which prevail. It is true that gas is formed by cooling the liquid in the liquid precooler, but this gas is compressed only in the second stage, thus decreasing the size and the work necessary to be done in the low-pressure cylinder. Some liquid is evaporated in the second intercooler, but the volume vaporized is only one-quarter of the decrease in the volume of the gas passing into and out of the intercooler. Finally, the temperature of discharge from the second-stage compressor is only 175 deg. F. (point *I*) instead of 350 deg. F. (point *B*) in Fig. 3. The clearance reëxpansion loss is reduced, as seen in Fig. 2, which is taken from actual indicator diagrams.

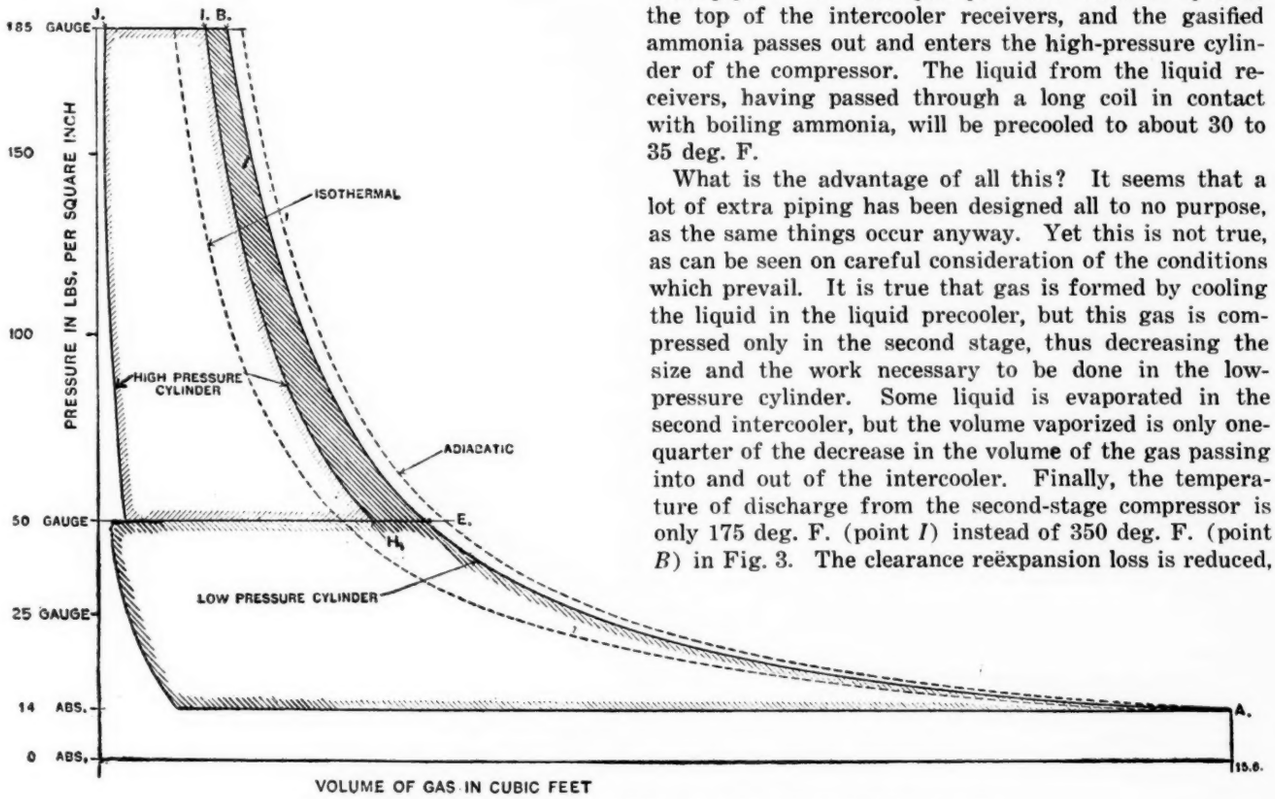


FIG. 3. SHOWING THE RELATIONS OF THE COMPRESSION LINES

The actual compression line for the high-pressure cylinder is that designated H. I. Intercooling reduces the volume and temperature of the gas at the end of low-pressure compression, and therefore the high-pressure terminal temperature or condenser temperature is considerably lower than it would be without intercooling.

It is seen from the diagram that the two compressors are driven from the same shaft, which may be engine, synchronous motor, or belt driven. If desired, separate drives may be made, as is done in the Central Manufacturing Co. cold-storage warehouse, of Chicago, where large units are employed. In this plant the low-pressure cylinder is called a "booster" and liquid cooling is used in a somewhat similar manner to that already described, which is known as the D. L. Davis method. In moderate-sized plants, however, the advantage of having the two cylinders on one shaft lies in the reduced torque and less flywheel and balancing troubles.

Three-Phase Power from Single-Phase Transformer Connections

By J. B. GIBBS
Engineer, Transformer Department, Westinghouse Electric and Manufacturing Company

A number of different ways of grouping single-phase transformers to step up or step down three-phase voltages are discussed, and their relative advantages and disadvantages pointed out.

MOST of the power systems in this country are three-phase, and most of them use single-phase transformers. There are several schemes by which such transformers can be connected into "banks" for the transformation of three-phase power, and the best scheme to use in any particular case depends on circumstances.

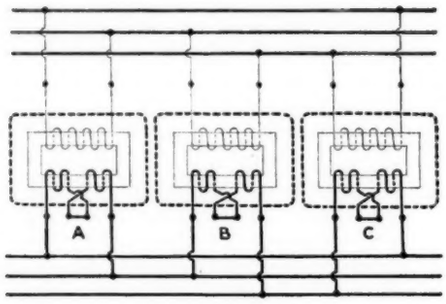


FIG. 1

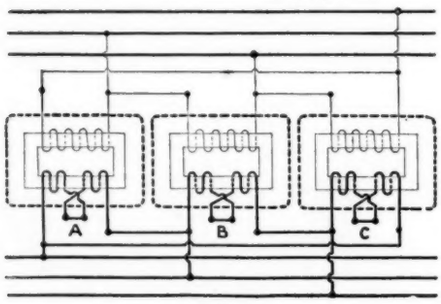


FIG. 2

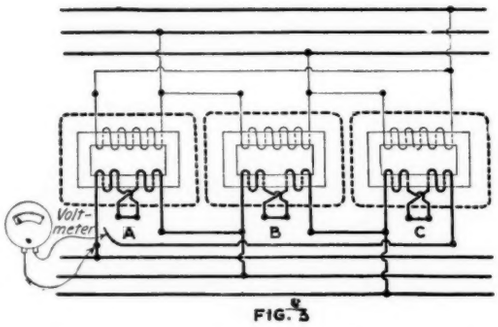


FIG. 3

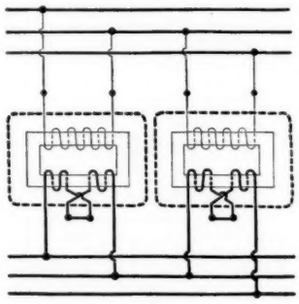


FIG. 4

FIGS. 1 TO 4. TRANSFORMER CONNECTIONS ON A THREE-PHASE SYSTEM

The connections for a delta-delta bank is shown in Figs. 1 and 2. Both figures show the same conditions electrically, and the connections are actually made in whichever way is more convenient. It will be seen that each transformer is connected between one pair of lines on both the primary and secondary sides, and with balanced secondary load each transformer supplies one-third of the total power. If the transformers have the same characteristics the relation of the voltages are such that the voltages of transformers *A* and *B* will add (vectorially) to give a voltage just equal and opposite to the voltage of *C* in both primary and secondary; and although there is closed circuit in the primary and another in the secondary, there will be no tendency for current to flow because the voltages are exactly balanced. A balanced load will then draw the same current from each transformer, and these currents will be 120 deg. apart. This is the ideal condition and one that is approached more or less closely in practice.

Suppose, now, that one transformer in Fig. 1 has a different ratio of turns from the other two, so that its secondary voltage will be a little higher. This voltage will not be exactly balanced by the resultant of the other two voltages, and the unbalanced part will cause a current to flow around the path formed by the three transformers. If a balanced load is connected to the secondaries of such a bank, it may be regarded as drawing a balanced current from the bank, as before, while the circulating current also flows at the same time. These two currents flowing in the windings of each transformer will combine to cause an overload on a part of the bank and an underload on another part, so that the bank, as a whole, will not carry its normal load without overheating in some part. If it is necessary to connect two transformers in delta with a third which has a different ratio, trouble may be prevented either by using an auto-transformer to correct the ratio of the third or by using a three-phase balance coil which will prevent the flow of circulating current without interfering with the load current.

There is another kind of dissimilarity which may give trouble in a delta connection. The three transformers may have exactly the same ratio of turns, but have different values of resistance and reactance. In such a bank at no load the voltages will be balanced and there will be no tendency for a circulating current to flow. But as the load is applied, the drop in voltage in the three transformers will be different, so that a resultant voltage will be produced, increasing as the load increases, and this will tend to cause a circulating current, as explained in the foregoing, with consequent overheating of a part of the bank, when operating under full load. This condition can be corrected by connecting resistance and reactance in series with the transformer which is low, to make its resistance and reactance equal the others, or by using a three-phase balance coil. In selecting transformers for a delta-to-delta bank, it is usually safe to assume that small transformers of the same size, say 50 kva. or less, will operate satisfactorily together. But before closing the corner of the delta on

the low-voltage side, it is always well to check the polarity of the transformers by testing with a voltmeter or lamps, as indicated in Fig. 3, to see if there is any voltage between the wires that are to be connected. This is especially necessary if the transformers come from different manufacturers. If the test shows no voltage, the connection may be completed.

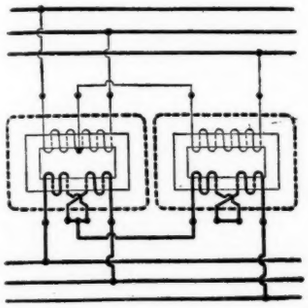


FIG. 5. TWO TRANSFORMERS CONNECTED IN "T"

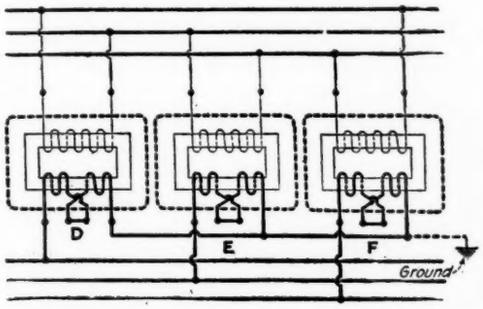


FIG. 6. THREE TRANSFORMERS CONNECTED DELTA TO STAR

One advantage of the delta-to-delta connection is that if trouble develops in one transformer it may be removed and the bank will not be entirely disabled. It will still carry 58 per cent of its normal load with two of the transformers connected in open delta.

The open-delta or "V" connection is shown in Fig. 4. Each transformer now carries a current due to the load on the phase to which it is connected, and in addition a current due to the load on the phase on which there is no transformer. The two currents are out of phase with each other, and the result is that each transformer carries a current which is about 15 per cent greater than that corresponding to the power delivered. The output of such a bank, therefore, is $\frac{1}{1.15} = 0.87$ of the total rated output of the two transformers. Thus two 50-kva. transformers connected in open delta will give $2 \times 50 \times 0.87 = 87$ kva. instead of 100 kva., and this is $\frac{87}{3 \times 50} = 0.58$, or 58 per cent of the output of a delta-to-delta bank of three 50-kva. transformers, instead of 67 per cent, as might be expected. The open-delta connection is convenient and takes only two transformers instead of three, and it is frequently used where small amounts of three-phase power are needed.

The tee connection is sometimes used for three-phase power and is shown in Fig. 5. Two transformers are needed, and as in the case of the open-delta connection, the total power delivered is only 87 per cent of the combined rating of the transformers. Not all transformers can be used for this connection. It is necessary to have the usual close magnetic relation between the primary and secondary windings, and in addition there must be close magnetic relation between the two halves of each winding in the "main" transformer, which is the transformer connected directly between the two lines. If this is omitted, the effect will be to put a reactance in series with the "teazer" transformer, and this may cause a serious unbalancing. This connection is rarely used except for transformation from two-phase to three-phase, or vice versa.

In Fig. 6 is given a delta-star connection. This connection is much used for step-up transformers. The neutral of the star side is sometimes grounded, as shown by the dotted lines, and sometimes not. If the ground connection is used, the maximum voltage that can occur from any line to ground is the voltage across one transformer. This limits the voltage stress on the high-voltage insulation of the transformers and line, but on the other hand, if one line becomes grounded accidentally, it means a short-circuit on the system. If the neutral is not grounded and an accidental ground occurs on one line, 73 per cent additional voltage stress is developed from the other lines to ground, but it may be possible to operate in this way until the grounded line is cleared. The voltage on the delta-connected windings is the same as the generator voltage, but the voltage on the star-connected windings is only 58 per cent of the line voltage. This means that the star-connected winding will have a smaller number of turns and a larger conductor than a delta winding for the same line voltage, and also that the star-connected winding will need less insulation, internally. On transformers for high voltages these are important points, for they permit coils that are relatively strong mechanically and economical of space.

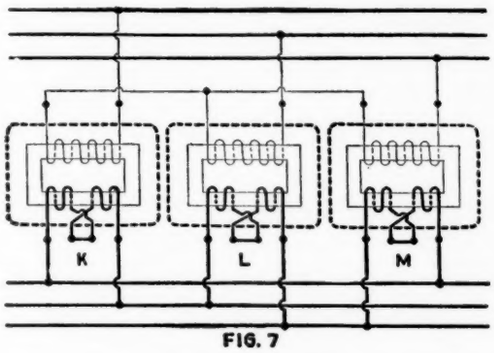


FIG. 7

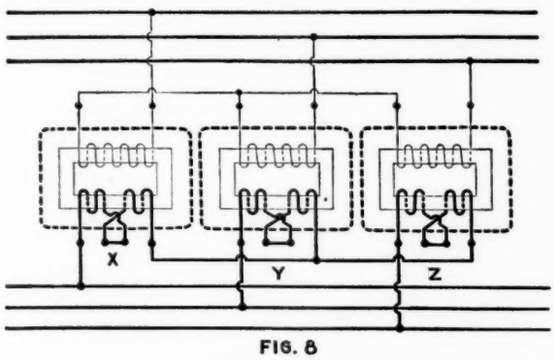


FIG. 8

FIGS. 7 AND 8. THREE TRANSFORMERS CONNECTED STAR TO DELTA AND STAR TO STAR

Fig. 7 shows a star-delta connection. This connection is used chiefly for step-down transformers and has the same advantages as described for the delta-star grouping.

Three transformers connected star to star are shown in Fig. 8. This connection has several disadvantages when compared with the connections, previously described, and it is seldom used. If a sine wave of voltage is applied to a transformer, the wave of magnetic flux

in the core must also have the sine form; but the characteristics of iron are such that in order to produce a sine wave of flux the magnetizing current must have a triple-frequency component. In a star-to-star bank this triple-frequency current would have to flow toward the neutral point in all three transformers at the same instant, but as there is no path by which it can flow away from the neutral point at the same time, it is prevented from flowing at all. This results in a flux in the core which is not of the proper form to give a sine voltage, and consequently the voltage wave form of such a bank is distorted. Such an effect is not produced if there is a delta connection either in the primary or secondary, because the delta connection provides a closed path in which the triple-frequency current can flow so as to supply the missing part of the magnetizing current.

The triple-frequency voltage thus generated in a star-to-star bank has several bad effects. If the neutral of the bank is grounded, there will be a triple-frequency leakage current to ground, which will cause trouble in any telephone lines that may be near. This trouble will be aggravated if the neutral of the generator is also grounded, because a complete path will be provided for the triple-frequency current. Under this condition it may even add something to the heating of the apparatus, but this effect is usually small. This system is not adapted to a four-wire, three-phase distribution, because any unbalancing of the load will shift the neutral point so that the voltages to the three lines will be unequal.

Three-phase power may be transformed by means of single-phase transformers connected in several ways.

The delta-to-delta connection is largely used on moderate voltages and has the advantage that it is not entirely disabled if one transformer breaks down. The open-delta connection is used frequently for small amounts of power and occasionally for larger amounts. Its output is 87 per cent of the combined rating of the two transformers. The "tee" connection is used occasionally. Its output is the same as the open delta.

Star-to-delta and delta-to-star connections are standard. They are especially valuable when transformers are to be connected to a high-voltage line, as the star connection decreases the voltage per transformer. A star-to-star connection is rarely used on account of trouble with third harmonics and with shifting of the neutral.

The Qualities of Success

By M. L. Brown

During years of experience as an engineer and an electrician, the writer has often striven to determine to his own satisfaction just what constituted the make-up of a successful chief engineer. What qualities must this person possess to enable him to take complete charge of a power plant, large or small, and in many cases the care of large industrial plants or buildings in conjunction with his power plant? It is a question that should be given serious consideration by all engineers who aspire to be leaders in their profession. It is impossible to lay down any set of rules that will apply to all cases, but there are a number of things that stand out so clearly above other necessary qualifications that they can be given without fear of contradiction.

First of all, an ambitious engineer should possess a fair education, and today there is little excuse for not having one. With correspondence courses, night schools, technical books, magazines and engineering societies, any man can acquire sufficient training in mathematics to enable him to analyze everyday problems in the plant. The engineer must possess or acquire the faculty of analyzing conditions and not jump at conclusions.

It is important to have a personality that appeals to the employer. Lacking this advantage, the engineer should cultivate it, because there is nothing that makes such a good first impression as a pleasant and attractive personality, and in most cases it secures the first opening as chief engineer.

In the course of his work and experience an engineer should acquire a training that will enable him to handle the mechanical end of his work, but even this seems to be a sort of a progressive game. A man might step from one plant as an assistant into another plant as an assistant without difficulty, but to step from an assistant's job to a chief's job is altogether another problem, and it is usually personality that secures it, other things being equal.

After an engineer has reached a chief's position, usually in a small plant, he should progress from one plant to another by easy steps until he has charge of a plant in which he is anxious to stay indefinitely. I do not mean that an engineer should be changing continually, but he should make progress. During this progress the writer has found it a question of work and then some more work, coupled with studying the plant equipment continually until it is mastered.

Subjects on which many engineers are weak where they should be well posted are the principles of combustion, practical and intelligent operation of the boiler furnace, and the analysis of electrical troubles. These subjects are not particularly difficult and yet it is surprising the number of times engineers will throw up their hands over electrical troubles where a little understanding of the principles of operation of electric apparatus and of diagrams would have made the solution easy. It is equally surprising to see what little changes in the boiler setting or in operating methods will do to the fuel economy.

The qualifications enumerated in the foregoing appeal to the writer as the fundamental requirements needed to be a successful engineer. Of course there are a number of problems that he must face as his position grows bigger, such as refrigeration, heating, building and plant maintenance, lighting, etc., but if he has learned to analyze conditions he can take care of those as they come, and it is wonderful the amount of help an engineer can get if he is actually desirous of securing information.

After securing the position of chief engineer, it is a question of keeping everlastingly at it to make good and to keep up to date. To help in this every engineer should join a society of engineers. He not only helps himself, but if he has the proper spirit he will help the other fellow who is trying to make a place for himself.

As the engineer makes progress he must expect and look for many hard knocks and experiences. He should at all times regulate his actions so as to gain and hold the confidence of his employer. If he possesses ability, integrity and resourcefulness, coupled with a willingness to coöperate, he need have no fear of losing his position as chief, because as a rule the firm is just as anxious to hold a good man as the man is to hold his job.

EDITORIALS

The Training of Leaders

THE recent conference in Philadelphia, between industrial executives and representatives of leading colleges and technical schools, has served to concentrate attention upon some serious defects in the education of engineering students. The schools have been fairly successful in training men to design and operate the machinery used in the industries, but they have not made any serious attempt to fit their students either for the handling of men or for the management of industrial enterprises. President Brush, of the American International Shipbuilding Corporation (which operates Hog Island), stated that every time he visited New York, he was importuned by heads of large corporations to find executives for them; that the main qualification needed in management is the ability to handle men, and that this has been completely overlooked by most of the schools.

The substantial accuracy of this statement cannot be questioned. The engineering graduate has usually been trained to deal with things inanimate and has not learned to consider man. Furthermore, throughout his college course he has not come under the broadening influence of contact with many men of many minds. In consequence of this he feels and is at a disadvantage in competition with men of larger experience of men and affairs and seldom rises to the higher executive positions in engineering enterprises. Both the engineer and the country suffer from this. Every year it becomes more important that the industrial executives should have a sound knowledge of engineering as well as a knowledge of men.

Some attempts have been made to meet this need by giving courses in "Engineering Administration," but this has resulted usually in a weakening of the technical courses without much appreciable gain elsewhere.

The best results that have been acquired so far have been through a system in which the students have alternated between college studies and supervised work in industrial establishments. Pioneer work in this direction was started about twelve years ago at the University of Cincinnati. This plan includes a biweekly alternation between college and industrial work for the whole five years of the course, and its success is unquestioned. A coöperative plan, established at the University of Pittsburgh about eight years ago, has also met with marked success.

At both these institutions the co-operation is under a director who arranges for placing the students at such work as will give them the best opportunities for experience, and who has free access to each student at all times. The students receive the same pay as other workmen doing similar work, and are treated like other workmen except in their relation with the director of coöperation. The director also meets groups of the students in the evenings to discuss with them their problems and experience. The student is given a syllabus of questions relating to his work the answering of which requires him to observe closely not only the processes which he himself is carrying out, but also the whole system of management of the factory and such general technical details as he has opportunity to observe. It also requires him to apply to his observations the engineering theory which he has acquired during his studies.

Announcement has recently been made that the Harvard Engineering School is about to put into effect a plan of coöperative work with the industries, which starts at the end of the sophomore year and has a unit of alternation of two months. The plan, as outlined, seems to promise well. It gives broad contact with other students during the most impressionable years, and it adds to the technical instruction, actual experience with labor, organization and management problems.

Senator Frelinghuysen Proposes To Settle the Bituminous-Coal Problem

SENATOR Frelinghuysen of New Jersey recently introduced three bills which he hopes will go far to correct the difficulties in the present coal situation. The first of these bills provides for the termination of Federal control in the coal industry by removing the powers conferred on the President under the Lever Act. The second provides for the appointment of a Federal Coal Commissioner, who will, however, have no authority to fix prices or control the industry, but whose duties shall consist of collecting information regarding coal-trade practices and the industry in general, and in making such information public. The third provides that the Interstate Commerce Commission may authorize a reduction in freight rates during the period from April 1 to August 31 of each year, and an increase during the remainder of the year.

Probably the first of the measures will be of no present effect, since the President has already relinquished control of the coal industry. To a man on the outside the chief feature of the second proposed law is that it provides for a new office carrying a salary of $10,000 a year, a secretary at a salary of $5,000 a year, and "such attorneys, special extra examiners, clerks and other employees as he may from time to time find necessary for the performance of his duties, and as may be from time to time appropriated for such offices." With all the present Government machinery for gathering statistics, the necessity of a few new five and ten thousand dollar jobs of this sort does not seem very pressing, especially under the present scale of Government expenditures. The experience with the late Federal Trade Commission, having much the same relation to general business as the proposed Coal Commissioner is to have to the coal industry, suggests that the principal result to be expected from such a body is the amount of public money it can spend.

The Senator's third bill really promises to accomplish something. It provides that the freight rates for coal

shall be filed with the Interstate Commerce Commission by the railroads as in the past. It provides further, however, that the Interstate Commerce Commission may authorize a reduction of fifteen per cent from these rates during the months of April to August, inclusive, and an increase of fifteen per cent during the rest of the year. Such a scheme would require the filing of no new rates and should not lead to any confusion, as the changes would automatically come on April 1 and on September 1 each year without the necessity of any special action.

The passage of this measure would seem to promise considerable assistance in the efforts to stabilize the bituminous-coal industry by encouraging summer buying. The question of lower prices for coal during the summer at the mines would still remain to be settled, but if the railroads are allowed to make this differential, it would make considerable difference in the actual price of the coal to the consumer if bought during the low-rate months.

It has been estimated that 100,000 new coal cars will be necessary to handle properly the usual seasonable demand during the coming winter. Aside from the question of the railroad's ability to finance the purchase of this many cars, there is the physical impossibility of having them built in time. In addition to this, if the railroads had these cars today, the locomotive and terminal facilities would be inadequate to handle the demand, and it is also physically impossible to sufficiently expand these facilities. Meanwhile, under the present conditions, probably thousands of freight cars will lie idle during the coming summer months unless some means to stimulate summer buying are resorted to.

Revising the National Electrical Code

TWENTY-THREE years ago, when the National Electrical Code was first promulgated there was practically nothing that those in the electrical industry could refer to as a guide in their work. There were no standard rules for making electrical installations, and as a consequence much of the work done was of a very inferior quality even when measured by the standards of that time. Electrical installations when improperly made, to say the least, imperil both life and property. From the efforts of insurance organizations to prevent electrical installations being made so as to introduce a fire hazard, the National Electrical Code has grown. The rules at first were but recommendations; however, they have grown until the code today is not much short of absolute law. This is one of the best indications of the wisdom of the policy adopted of revising the code every two years. The recommendations of the 1920 revision were considered at a meeting of the electrical committee of the National Fire Protective Association held in New York City, March 23 and 24, and it is expected that the new code will be ready for distribution during this summer.

The real importance of the National Electrical Code is too frequently not appreciated even by those in the electrical industry. If for no other reason, the code is of great value because it represents the best knowledge and experience in the installation of electrical apparatus and wiring in America. It is not the result of experience of fire-insurance interests alone, but of the best thought in the electrical industry. The committee that revises the code includes representatives of the National Electric Light Association, American Institute of Electrical Engineers, American Electric Railway Association, National Electrical Contractors Association, United States Bureau of Standards, besides representatives from national and municipal bodies interested in fire prevention and underwriters' organizations.

Delayed Maintenance

ONE of the great dilemmas of industry in recent years is maintenance—when to do it, how long to delay doing it. The reason is cost—cost of labor and material. The inclination is to put off the work in the hope that the equipment will satisfactorily continue functioning until costs go down. This practice has been and is now general; the railroads, all industries with exceptions, have allowed needed repairs, overhauling, all kinds of maintenance work, to drift until—well, until the dire necessity of keeping things together compelled it. Material of every kind is burdensomely high in price and has been for a long time. Reported statements of governmental department heads, of brokers, of marketmen generally, are to the effect that we have reached the peak of prices of raw materials. Granting that this is true, it will be some time before the decrease is reflected in lower prices of finished commodities. And their trend now is still up, not down. The butcher, the baker, the candlestickmaker now chorus: "They will go higher." So there is little immediate comfort in announced lower prices of raw materials.

In the power plant it is poor business policy to allow equipment to become badly in need of maintenance. The engineers, and no less the management, must not forget that the power plant is vital. Without power industrial civilization would perish. The failure of a part of an engine, turbine or other piece of apparatus may mean the temporary failure of a whole mill or factory. Whatever the real deep-seated cause of such an interruption, the engineer or power man, whatever his particular title, will be blamed and held responsible. After the fact it will avail the engineer little to explain that he warned this one and that one of the impending failure. Carbon copies of his warnings and requisitions for parts or material for parts may help him. Further, the man who is rightly jealous of his reputation appreciates that accidents that occur to machinery in his charge, whether or not due to his direct negligence, are charged against his reputation both in his plant and elsewhere.

Extravagance is inexcusable; but the wise engineer will see to it that he does not endanger life, property or continuity of service by delay in urgent maintenance.

Just as refrigeration reaches a state of high commercial perfection and finds ever-widening application, along comes a fellow with a prospectus about dehydrating everything from soup to nuts, thus wiping cold storage off the slate with one fell swoop. And the breweries gone, too! Dehydration of foods has its serious and favorably potential sides, but time will likely show it to be an aid to refrigeration rather than an improvement upon it or successor of it.

This is not the time to "saw wood" about electrification of the lumber industry in the Northwest.

CORRESPONDENCE

Why Blame Caustic Soda for Boiler-Plate Cracks?

The explosion of a steam boiler in Canada, caused by the cracking of a drum head, is still the subject of much discussion. (See *Power*, July 8, 1919, pages 70 and 71 and a further contribution to this subject by G. H. Garrison, *Power*, Sept. 23, 1919, page 515). The latter article asks the question why caustic soda was blamed without proof of its presence. The following reply was given: "The boiler plate in proximity to the leak was covered with a white deposit, and the fracture was such as has characterized previous failures traceable to this cause."

The purpose of the following is to show that the "white deposit" and the "characteristic fractures" are not proof of the presence of caustic soda.

Professor Parr in the University of Illinois Bulletin No. 94, to which the article at page 71 refers, described as follows cracks possibly due, in his opinion, to caustic soda. (See page 11 of the Bulletin): Fine cracks develop and proceed from the rivet holes, always below the water line, and in the University of Illinois boilers, always in conjunction with a leak or other condition which promotes a concentration of the soluble material to the saturation point.

The fact that rivet-hole cracks or cracks in or near seams were found, apparently led to the assumption that uncontrollable concentration of caustic soda in inside interstices of seams may take place. However, this has not been proved as yet and does not appear probable for the following reasons.

Caustic soda or other sodium salts are present in the contents of many boilers. In many cases caustic soda or sodium compounds, from which caustic soda may develop, are put into the boiler intentionally for the purpose of overcoming troubles which would occur in their absence. Experience with such boilers has proved that caustic soda does not affect the boiler if its amount is controlled by keeping the concentration of the boiler contents within certain limits.

From the analysis of the Urbana water, page 8 of the Bulletin, and from the composition of the concentrated liquids in the boilers, page 52, it can be calculated that approximately 500 grains of magnesium hydroxide and approximately 1,000 grains of calcium carbonate would be contained in suspension in, or be precipitated from, one gallon of the concentrated liquid before the concentration of the caustic soda would reach 234 grains per gallon, which is, according to the Bulletin, a concentration not only harmless but even beneficial. The scale-forming substances will also enter the interstices of the seam, if such interstices exist at all, and there they will precipitate.

Much work has been done in the last thirteen years to find the causes of cracks in boiler plates. It has been found that there are many possible causes. Most of them have been verified by duplicating them in experiments under conditions which eliminated other influences than those to be investigated. Cracks in boiler plates of good material have been traced, in the absence of other manifest causes, to internal strains resulting from mechanical or thermal treatment. Since most of the work during fabrication is done on the seams, and as thermal influences during operation of the boiler will be greater in seams than in single plates, it is obvious that fine cracks due to internal strains will more frequently occur in the seams.

Shearing, dressing, rolling and hammering of the plates, punching, reaming and drilling of holes, pin drifting and injudicious forcing of plates into surface contact, riveting and calking, expanding of tubes into tube sheets, and careless handling of tools for removing boiler scale are possible sources of brittleness and cracks by bad mechanical treatment. Burning, working the material at blue heat or too much cold working, both without annealing, sudden heating and cooling, insufficient cooling of the walls on the water side due to scale or oil, low water in the boiler, possibly followed by feeding cold water, etc., are the main causes of brittleness and cracks by thermal treatment.

It has also been shown that brittleness and cracks caused by internal strains will be further developed by operating stresses which are greatest in and near seams, or by sudden changes in temperature. Changes in temperature occur more frequently and within wider limits near the grates than more distant therefrom, and this may be one of the reasons why cracks are more often observed in the water spaces than in the steam spaces of boilers. The steam spaces are not always heated and if so, then the flue gases touch them only just before the gases enter the chimney—in other words, farthest from the grates.

Most valuable contributions regarding the problem of cracks in boiler plates have been made by, among others, Stromeyer, Bach, Baumann, Heyn, Bauer, Daibler, Houghton, Stead, Wolff, Rosenhain and Hanson. They have been published in the *Journal of the Iron and Steel Institute, Stahl und Eisen, Zeitschrift deutscher Ingenieure* and *Proc. New York Congress for Testing Materials* from 1907 to 1918. Wolff, *Journal of Iron and Steel Institute*, 1917, gives, besides the results of

his own investigation, a short abstract of the work of Kirsch, Foeppl, Leon and Preuss, and refers also to the investigations of Talbot, Howard and Bartho, which have a bearing upon the subject if the further development of existing cracks during operation is to be considered. Wolff also stated that the rivet-hole cracks which he found, occurred not only in the water spaces, but also in the steam spaces of boilers, that they were extremely local and that in most cases no leakage was observed and no boiler scale found between the plates.

Cracks in rivet holes resulting from internal strains cannot easily be detected, since they are hidden from the eye and can be seen only after the rivets are removed. This, of course, will in general be done only when a leak occurs which canot be stopped and which indicates that there is something wrong with the seam.

In Bulletin No. 94 the only test mentioned which has been made with caustic-soda solution of a concentration permissible in a boiler, Table 10, page 56, shows that in this case boiling of the test pieces for fifteen days at a temperature of 200 deg. C. did not change their physical properties for the worse. On the contrary, the alternate bending test showed an improvement of 8 per cent and the impact test showed no change as compared with the untreated sample. This result is quite in accordance with those obtained by Thompson (*Journal, Society of Chemical Industry*, 1894) who found that boiling in caustic solutions of moderate concentrations (which were higher than those usually permitted in boilers) did not appreciably change the physical properties of steel wire, while boiling in water changed them for the worse.

Comparison of the results given in Tables 1, 4 and 5 of Bulletin No. 94 shows that the properties of annealed test pieces have been changed to a much smaller degree by boiling in caustic soda than those of test pieces in which internal strains by bending were introduced before such treatment. This points to the influence of internal strains and is completely in accordance with the results obtained by Stromeyer, Bach and Baumann.

In good boiler practice the amount of all salts dissolved in boiler salines should be below 1,000 grains per gallon. With the exception of one test, which was made with a solution of a concentration within this limit, and which confirmed the beneficial influence of caustic soda, all other tests made at the University of Illinois were made with solutions containing 6,500 grains and up to 60,000 grains of caustic soda per gallon. Furthermore, Professor Parr, on page 11 of the Bulletin, called special attention to the fact that the purpose of his studies was not an attempt to explain the cause of boiler failures. He emphasized that much work remains to be done before a complete and adequate explanation of the case can be offered.

Therefore, no conclusions should be drawn from the results given in the Bulletin, so long as it has not been proved that similar concentration in fact existed in the boiler, and because the cracks in or near rivet holes are not specific characteristics of embrittlement by caustic soda, but result, as has been proved, from internal strains due to other causes, and further no cracks have been developed in specific laboratory tests with caustic soda.

In the Canadian case it has not been proved that the water used contained caustic soda and that the accumulation of incrustations were of alkaline character, or that there were cracks developed from rivet holes. The white deposit mentioned proves only that there was a leak, since not only caustic soda, but all salts which are usually contained in boiler water, are of a white color, as for instance, all the chlorides, sulphates, carbonates and hydroxides of the main scale-forming elements, calcium and magnesium, as long as they are not colored by iron salts (rust), organic matter, etc. Therefore, it is obvious that the Bulletin gives no basis for drawing the conclusions referred to.

The crack described in the Canadian case shows, however, a certain characteristic not mentioned by Professor Parr; namely, that it, in general, follows a line which is near and parallel to the calked edge of the overlying plate and that its larger part is situated between the calking edge and the row of rivet holes. The crack shown in Figs. 1 and 2 on page 70 of the July 8, 1919, issue is similar to that of a boiler exploded in Wisconsin and shown in Fig. 2, page 605, of *Power*, Oct. 21, 1919. The latter crack occurred along a longitudinal seam above the water line, as stated in the description. Similar cracks along the calked edges of the overlying plates have occurred in steam boilers used for concentrating caustic soda and in steam boilers in which no caustic soda was present—in both cases above the water line as well as below. The occurrence of such cracks above the water line could not have been caused by caustic soda, and since the characteristics of the cracks below the water lines are the same and in a number of cases occurred in the same boilers as those above the water line, one cannot see why the former should be considered to be caused by caustic soda while the latter certainly were not. The cracks along riveted seams above the water line, however, can, in the absence of other manifestations and when good material has been used, be explained only by internal strains resulting from mechanical or thermal treatment or both.

Users of steam boilers, owners as well as operators, can assist the solution of the problem in question by careful operation and examination of their boilers and calling experts when irregularities are observed. If they do this, many troubles will be prevented. Periodical inspection of boilers by experts is of great importance. Making use of the services offered by the steam-boiler inspecting and insurance companies and similar institutions cannot be too strongly recommended.

New York City. H. KRIEGSHEIM.

Freeze-Proof Mixture in Gage Siphon

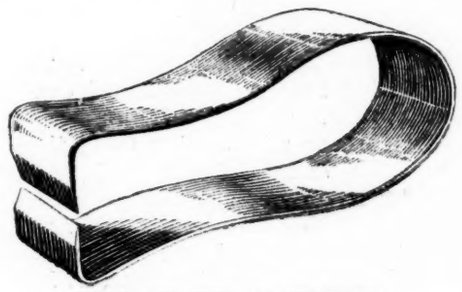
I cannot agree with Mr. Coyne, on page 433 of the March 16 issue, as to the introduction of freeze-proof mixture in siphon of steam gage, unless a special piping arrangement is used to trap the evaporation of the freeze-proof mixture, also to prevent the accumulating condensation from floating out of the siphon. Otherwise the kerosene, if used, or the nonfreezing mixture will not be effectual.

It is possible for the safety-valve springs to become permanently set even in a well-managed plant that is operating up to or over rating. Mr. Coyne's suggestion to close the stop valve when the boiler is operating at or beyond capacity, in order to test the capacity of the safety valve is really one of the State of Pennsylvania Safety Standards. But why not test the valve before the boiler is put on the line?

Uniontown, Pa. H. D. NOLAN.

Wire Scraper Made from Hacksaw Blade

A very handy wire scraper for use around a repair shop and in armature winding, can be made from an old twelve-inch hacksaw blade. Put the blade on the emery wheel and grind off the teeth. Then by using two pairs of pliers, hold it in a blowtorch flame and heat to a dull red and bend it in the shape shown in the figure.



WIRE SCRAPER COMPLETED

Heat and bend only a small portion at once and do not let it get very hot. Allow the blade to cool slowly and do not put it in water. When in the proper shape and cooled, grind the ends to bevel inwardly as shown.

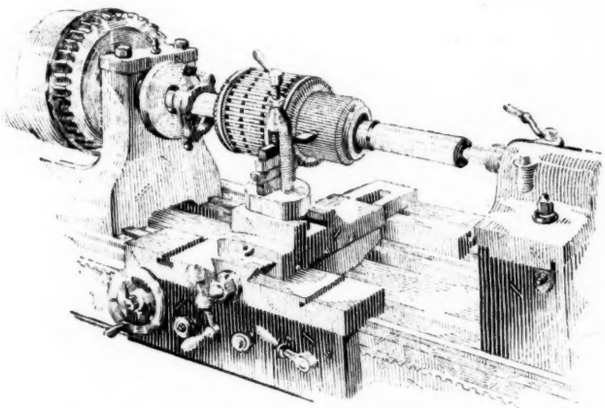
This tool is very handy for scraping solder from old commutator leads or for removing cotton insulation from new leads.

J. W. FAGER.

New Orleans, La.

Slotting Commutators in a Lathe

There are various devices for slotting the mica from between commutator segments. We have found it very effective to do the work in the lathe after the commutator has been turned off. Make a small parting tool,



ARMATURE IN LATHE READY TO HAVE MICA SLOTTED FROM BETWEEN SEGMENTS

a little narrower than the mica between the segments, and set it horizontally in the tool post, as indicated in the figure.

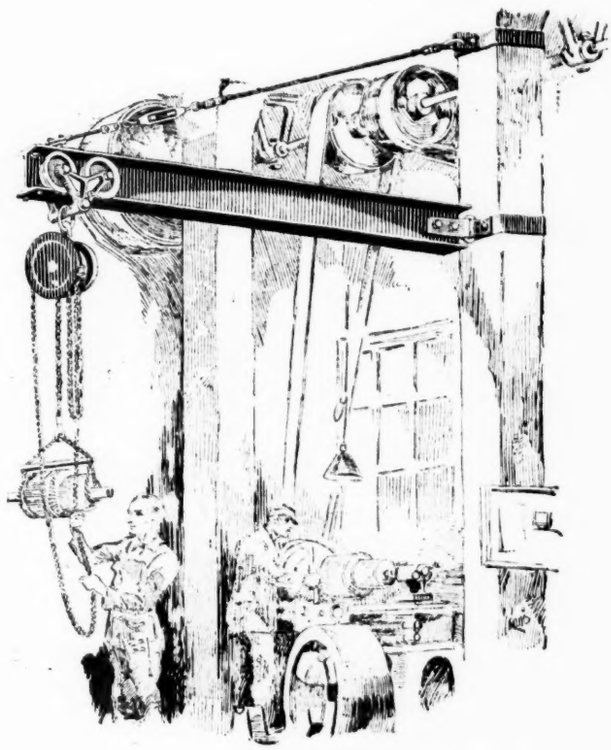
Take off the driving belt and put in the back-gear, block the dog in the faceplate slot with a wooden wedge to take up the lost motion, then turn the cone pulley by hand to bring the mica in line with the tool and push the tool through the mica by moving the carriage toward the headstock with the hand gear.

A. H. HALLADAY,
Master Mechanic Spring Valley Coal Co.
Spring Valley, Ill.

A Handy Shop Crane

In repair shops where there are no cranes it is always more or less of a problem how to handle pieces of equipment of only medium weights, to say nothing of the larger parts. Where lathes and other machine tools are located within eight or ten feet of a column, the handling of parts can be greatly simplified by the use of the home-made monorail crane that is shown in the figure.

This device consists of ordinary 4- or 6-in I-beam, one end is fastened to a column by a two-part band, the latter made so that it can be tightened on the column by two bolts. The outer end of the boom is supported from the top end of the column by a two-part band. On the I-beam is placed a trolley such as can be purchased at most any machinery supply house, and from this trolley a chain fall is supported.



CRANE INSTALLED IN SHOP

This crane can be operated through a radius of at least 180 deg., making it useful in transferring equipment from one part of the shop to another at will, as well as lifting parts in and out of machine tools. By putting up a special mast in the shop to support the boom from the crane can be so constructed as to have a 360-deg. travel. The length of the boom will depend upon how high the ceiling of the shop is; the boom rod should make not less than about 30 deg. with the boom and 45 deg. is better.

Different conditions will require different methods of solving the lifting problem in the shop, but with the foregoing idea in mind the resourceful repairman should have no difficulty in easily providing his shop with facilities for handling all heavy parts. Such cranes will also be found invaluable in erecting equipment in the shops.

B. A. BRIGGS.

New York, N. Y.

Distance of Bridge Wall from Boiler Shell

In the Feb. 24 issue of *Power*, page 309, Albert L. Smythe makes inquiry concerning the height of bridge walls for his boilers. The question is not so simple as it appears and is of considerabe importance, particularly in the bituminous-coal region. Before determining the proper height of the bridge wall, it may be well to outline the functions for which it is intended:

1. To retain the fuel on the grates, its height being a little above the proposed thickness of the fuel bed.

2. The bridge wall should be of such distance from the boiler shell as not to restrict the passage of the gases arising from the fuel bed, and this distance should be inversely proportional to the draft that is available.

3. Considerable free air enters at the back end of the fuel bed, where the grate is farthest from the fireman and is more difficult to maintain uniformly covered. Unless the air so admitted is retained long enough in the furnace to acquire the same temperature as the gases arising from the fuel bed, it will pass along toward the stack without an opportunity to mix with the combustible gases; that is, the free air, being heavier than the gases from the coal, will sweep through the combustion chamber as an underlining to the gases of higher temperature. This is particularly true in furnaces burning high-volatile coal.

4. Absorption by the boiler of radiant heat from the fire depends largely on the intervening distance, and therefore it is desirable to have the boiler as close to the fuel bed as the requirements of good combustion space will permit.

5. Draft in all cases should be so utilized as to secure the best results, and any unnecessary restriction without proper or adequate returns is undesirable waste.

Summing up, it is my belief that the bridge wall should be as high above the grates as possible, provided it does not restrict the gas passage above it, and the boiler should be as near to the fuel bed as conditions will permit.

With a chimney 100 ft. high serving two boilers, one 78 in. x 19 ft. and the other 72 in. x 18 ft., with grates 6 x 6 ft., the chimney draft at the damper will range from 0.55 or 0.5 in. of water. The loss in draft permissible from the fuel bed to the back end of the boiler is less than 0.05 in. and the area over the bridge wall should be 25 per cent of the grate area, or $36 \times 0.25 = 9$ sq.ft. The first dimension, the width of the opening over the bridge wall being 6 ft., the second required dimension, the distance from the top of the bridge wall to the nearest point of the shell, will be $9 \div 6 = 1.5$ ft., or 18 inches.

It is understood that the bridge-wall top will be straight and not curved to coincide with the curvature of the shell. The 18 in. is the distance between two straight lines, one drawn on top of the bridge wall and the other tangent to the outer circumference of the boiler shell at the nearest point to the top of the bridge wall.

Although 25 per cent of the grate area between the boiler shell and the bridge wall is only a working rule, it meets the requirements in most cases. Hand-fired furnaces are difficult to operate at a much higher rate than 25 lb. of coal per hour per square foot of grate area, so that the rule is based on this rate of combustion. If in the plant under consideration, both of the boilers are operated, as they should be, at the maximum capacity of the grate area, the total coal per hour burned by each boiler will be $36 \times 25 = 900$ lb., which will develop approximately 180 to 200 hp. Assuming 20 lb. of gas per pound of coal and 52 cu.ft. in a pound of gas at 1,800 deg. F., the volume of gas to be handled will amount to $900 \times 20 \times 52 = 936{,}000$ cu.ft. per hour $= 260$ cu.ft. per second. The velocity of gases passing over the bridge wall can be 30 ft. per second without exceeding the allowable loss of draft. The furnace width being 6 ft., the required third dimension will be, $260 \div (30 \times 6) = 1.44$, or practically 1.5 ft. $= 18$ in., which should be the distance from the bridge wall to the boiler shell.

As to the height of the bridge wall above the grates, in all cases it should be no less than 16 in. In case the boiler is so set as to make it impossible to provide a 16-in. bridge wall, the grates should be dropped at the back end, say about 1 in. to the foot. If this does not give the desired height, then the area over the bridge wall may be reduced to, say, 20 per cent instead of the desired 25 per cent.

The best bridge wall for burning bituminous coal rises 18 to 20 in. above the grates, and the space between it and the shell for gas passage should be equivalent to 25 per cent of the grate area. The area above the bridge wall should be taken as a rectangle, one dimension being the width of the bridge-wall top and the other the shortest straight line from the bridge wall to the shell.

The extra area available at both sides, due to the curvature of the boiler shell, is considered only in extreme cases, which usually require long practical experience to enable one to assign relative importance to the various factors involved.

Chicago, Ill. HENRY MISOSTOW.

In a boiler plant formerly under my supervision, containing eighteen 125-hp. return-tublar boilers, each 16 ft. long, 72 in. shell diameter and containing seventy 3½-in. tubes, stoker-fired, the distance of the grate line from the boiler shell was 60 inches and the distance of the bridge wall from the boiler shell 18 inches. It was found that when the bridge wall was maintained at 18 in., satisfactory results were obtained and the fire would not hog away at the end of the grate surface nearest the bridge wall, whereas when the bridge wall would slough away to around 24 in. the fire would not burn properly and required considerable working to keep it in condition around the vicinity of the bridge wall.

In addition to maintaining the bridge wall, it was also found to be of advantage to build the wall straight down to the floor line of the combustion chamber instead of tapering it, as the former design gave more space for the proper mixing of the gases of combustion, resulting in flue-gas temperatures of around 500 deg. F. and flue-gas CO_2 of 12 per cent average. Keeping the tubes and the interior of the boiler clean and the air leaks stopped were as important as anything else in producing good results.

In Mr. Smythe's case I feel that, if the bridge walls of his boilers are maintained at 12 in. from the boiler shell, and the grates set from 36 to 44 in. from the shell, with the other practices I have followed, he will

certainly obtain better results than by having the bridge wall set 18 in. or more from the shell. For stoker installation I find 18 in. space satisfactory. This, in my opinion, is too much space when firing bituminous coal on hand-fired grates. Ten inches is slightly too close for good economy, as the furnace would not have sufficient gas outlet and there would be a waste of fuel.

I would further suggest that Mr. Smythe procure a flue-gas analyzer and portable pyrometer or flue-gas thermometer, and with these instruments he can prove to his superior officer whether he is right or wrong at any time. Personally, I would not be without these two instruments, even if they were used only a few times a year. PAUL R. DUFFEY.

Hagerstown, Ind.

Pulverized Coal Under Boilers

In regard to the results obtained with powdered fuel in Milwaukee, as outlined in the article by John Anderson, on pages 336 to 339 and 354 to 359 of the March 2 issue of *Power*, the writer believes it is fundamentally wrong to take coal and prepare it to the most expensive condition imaginable (powder) and still burn it in its raw state; that is, with all its hydrocarbons. A much more fertile field for research and more rational procedure is to extract some or all of the byproducts, leaving coke and gas for fuel. Ultimately, we must come to some such process in this country, and until that time it will be difficult to find a complete analysis of figures that will show anything but a loss for powdered fuel as compared to stoker firing.

The ash carried out by the chimney gases is a serious matter. It is reported at 82.8 per cent of the ash content of the coal. This is an item that should not be lightly passed. It is not sufficient to simply state that it is "apparantly carried a long distance" or that "no deposit could be noticed in the street." Some accurate way of measuring this discharge should be found before definite statements concerning it are made.

In figuring the cost of coal preparation, only the equivalent fuel cost was charged and that at 1.5 lb. of coal per kilowatt-hour. This figures 17,826 B.t.u. per kilowatt-hour. Few, if any, stations can assume such economy as this. The correct figure for cost of current should include all items—coal, labor, capital charges; in fact everything that goes to make up the ultimate cost of a kilowatt-hour at the point of consumption.

The cement industry has used powdered coal for twenty years and no doubt has much more data on the subject than steam producers. Such plants with established figures on cost of pulverizing coal, find that it costs in excess of $1 per ton to prepare the coal. If complete costs were figured for the Milwaukee installation, the cost of preparation will probably approach this figure and more than offset the alleged saving.

The type of stoker with which the comparison is made, has a 5.9 per cent difference between the gross and the net efficiency. This allowance for auxiliaries cannot be taken as typical.

From the author's presentation of the subject the writer believes therefore; first, that the ash nuisance is unsolved; second, in order to present even a slight saving in favor of pulverized coal, it is necessary to use low-moisture coal, omit interest and depreciation on the additional investment, omit a portion of the cost of preparing the fuel and make a comparatively large deduction for stoker auxiliaries.

Correcting these items, the showing in economy would be in favor of stoker firing. T. A. MARSH,

East Chicago, Ind. Green Engineering Co.

Calculations From a Flue-Gas Analysis of Loss Due to Incomplete Combustion

On page 129 in the Jan. 27 issue of *Power* is published an article by H. B. Brayton, entitled "Calculations from a Flue Gas Analysis of Loss Due to Incomplete Combustion," and showing formulas for calculating the latent losses of heat. These data have been thoroughly perused by me, and I must say that Mr. Brayton's methods are excellent. While he says little in text form about the great danger (from an economical point of view) resulting from the formation of carbon monoxide and hydrocarbon in flue gases, he leaves everything to the readers and lets his formulas speak for themselves. Those who have gone over the matter carefully will agree that the figures given make it easy to arrive at accurate results.

Since carbon monoxide and hydrocarbons ($CO + CH_4$) are the combustible constituents (we must not forget the latter) the presence of which causes considerable loss of fuel in most boiler plants above and below a certain percentage of carbon dioxide, it is evident that, since we can record CO_2, an instrument for the continuous analysis of CO and CH_4, together with the CO_2 recorder, would undoubtedly form a mighty fine piece of boiler room control by direct method.

Mr. Brayton's formulas, as clear as they are, are only then of real value when means for accurate determination of the combustible gases are at hand. For this purpose he recommends an Orsat apparatus to determine the carbon monoxide. However, the manipulation of such hand gas analyzer with particular reference to carbon-monoxide analysis is a difficult one, and even though the percentage of CO might have been accurately determined, the hydrocarbons cannot be arrived at with this method. Moreover, the simplified apparatus now put out by various concerns for power-plant use are equipped with burettes of only 50 cubic centimeters, reducing the accuracy considerably. Then, too, while with cuprous chloride and a great deal of patience finally one of two more or less accurate analyses may have been obtained, they in themselves are of no real practical value, as they only represent two snap samples showing what the CO has been from 10 to 15 minutes before they were taken (5 minutes is required for a correct analysis of CO). Thus we may as well forget all about CO analysis.

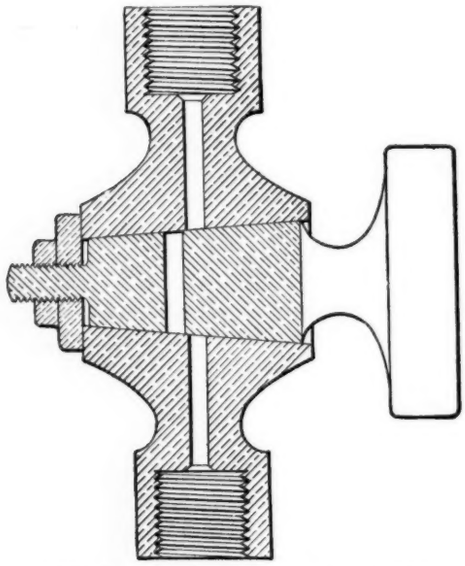
Hydrocarbons may be present in ordinary boiler-room practice to the same detrimental extent as CO, depending greatly, of course, upon the kind of fuel used and certain other conditions; therefore, in no cases where we speak of combustible gases must this hydrocarbon be forgotten, which in itself explains that CO tests taken with the ordinary apparatus are meaningless.

Continuous analysis of CO_2 and continuous analysis of CO and CH_4 is of real value and a reliable instrument that requires but little attention and is capable of analyzing the three gases mentioned would be worth having. F. D. HARGER.

Buffalo, N. Y.

Too Much Regrinding of Stop-Cock

The erratic action of the steam-gage was called to my attention by the fireman, who said the gage made a jump of 20 lb. all at once. I investigated and found



RESULT OF TOO MUCH REGRINDING

that the cock in the steam-gage connection had become blind on account of many grindings, as shown in the sketch.

Sometimes a little thing like the foregoing may cause great damage. THOMAS NEILSON.

Philadelphia, Pa.

Solution of a Heating Problem

Until recently the buildings of the National Headquarters of the American Red Cross in Washington, D. C., were heated by two separate heating systems. The original large building, requiring 16,000 sq.ft. of hot-water radiation, was served by two sectional, cast-iron hot-water boilers having a capacity of 13,725 sq.ft. of hot-water radiation each. The four annexes, requiring a total of 15,681 sq.ft. of steam radiation, were heated by three sectional, cast-iron water-tube steam boilers, located in a boiler room in the fourth annex. These three boilers have a capacity of 32,500 sq.ft. of steam radiation.

In September, 1919, it was required that the heating plant be rearranged so that the main building, which was equipped for hot-water heat throughout, could be heated from the steam boilers in the fourth annex.

It was first decided to reduce the amount of radiation in the main building, change all the piping and heat the building by steam direct from the boiler plant. After estimates had been obtained for this work, it was found that such a plan would be too expensive, the lowest estimate obtained being $19,000.

The system which is now in operation was then designed, a brief description of which follows:

The piping in the boiler room of Annex 4 was rearranged in such a manner as to insure an even distribution of steam. A 10-in. main was laid in a concrete conduit, covered with concrete slabs, from the boiler room of Annex 4 to the boiler room of the main building. The boilers in the main building were removed. Two specially designed converters were installed. These consisted of a cast-iron shell, 20 in. in diameter and 48 in. long, filled with drawn copper pipes terminating in a head. The head is provided at top and bottom with 10-in. connections for the feed and return mains of the existing hot-water heating system.

Steam from the aforementioned 10-in. main is introduced into the shell through a 7-in. connection at the top of each tank. The condensation from the tanks is carried to a receiver which is emptied into the boilers at intervals by means of a three-stage, automatic, electrically driven pump. Thermostatic regulators are placed in the steam lines to each of the tanks, controlling the temperature of the water circulating in the system.

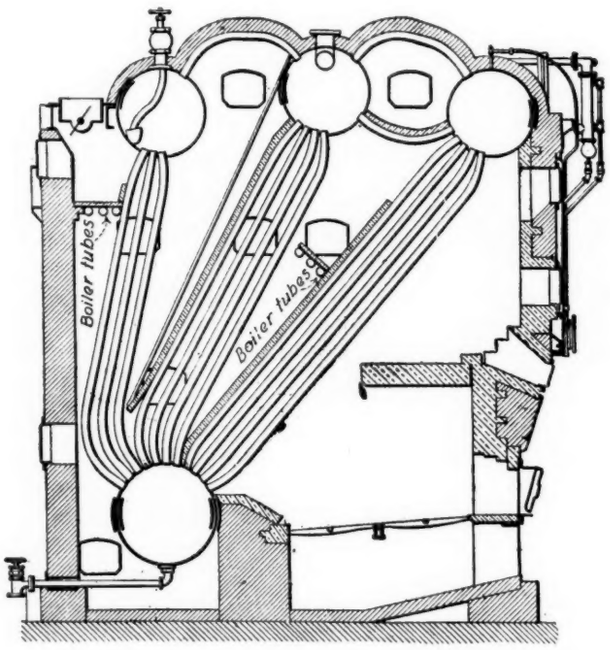
The greater part of the work was done during the cold weather, and at no time were any of the buildings without heat, as the boilers in the main building were operated up to the time that the new system was cut in.

The heat throughout all of the buildings is much more satisfactory than ever before, and the operation of the present system costs less than half of the operation of the two old systems. The completed cost of the system now in operation was $8,300.

Washington, D. C. J. P. LAWYER.

Using Boiler Tubes in Place of Angle Irons for Supporting Baffles

The illustration shows a way of using old boiler tubes in place of angle irons to hold up baffles in the



BOILER TUBES USED TO SUPPORT BAFFLES

Stirling type of boiler. By leaving one or both ends of the tubes flush with the outside of the setting, air will pass through them and keep down the temperature of the baffle support, whereas an angle iron would warp and let down the baffle. L. S. SHAW.

Cleveland, Ohio.

INQUIRIES OF GENERAL INTEREST

Blind of a Valve—What is meant by a valve being one-eighth inch blind? C. T.

The term blind is sometimes used with reference to a valve to signify that it is closed. One-eighth inch blind would signify that the valve overlaps the opening edge of the port one-eighth inch.

Advantages of Four-Valve Engine—Why is a four-valve engine more economical than a single-valve engine? W. L.

Four-valve engines can be designed and constructed with shorter steam passages and less percentage of waste cylinder-clearance spaces than necessary for single-valve engines; and the valves can be adjusted and controlled independently of each other so as to obtain better steam distribution, especially with a variable load.

Size of Uptake for Horizontal Return-Tubular Boiler—What should be the size of smoke uptake for a 72-in. x 18-ft. horizontal return-tubular boiler? W. L. M.

The uptake area is usually made one-eighth the area of the grate, although, with tight connections and a tall stack this figure may be considerably reduced. However, it is well to provide for extreme conditions and allowing for 40 sq.ft. of grate area, and one-eighth grate area for that of the uptake would give 5 sq.ft., or 720 sq.in. for the cross-sectional area of the uptake.

More Convenient Observation of Blowoff Leakage — Our boiler blowoff line discharges to an open sewer at some distance from the boiler room. What method can be employed to indicate near the boiler whether there is leakage of the blowoff valve? B. H.

If the blowoff line is so arranged that there is a vertical length conveniently observable and readily sprung apart when cut and supplied with a bolted flange union, insert such a union and each time, after blowing down, remove the bolts and insert a piece of tin plate between the flanges. Any leakage then will be revealed by water intercepted by the tin plate overrunning its edges.

Increase of Power by Operating Condensing—What would be the increase in power of a 12 x 18-in. engine running 200 r.p.m. noncondensing, if operated condensing with 26 in. vacuum? A. B. T.

A 26-in. vacuum is a pressure $26 \times 0.491 = 12.76$ lb. per sq.in. less than atmospheric pressure. If the back pressure when operating noncondensing is 2 lb. per sq.in. above atmospheric pressure, the reduction of back pressure from operating condensing would be $2 + 12.76 = 14.76$ lb. per sq.in., and the power would be increased

$$\frac{14.76\ (12 \times 12 \times 0.7854) \times 18 \times 2 \times 200}{12 \times 33{,}000} = 30.35 \text{ i.hp.}$$

Proportions of Link Valve Gear—For a link-motion reversing valve gear, what should be the length of eccentric rods and dimensions of the link, in terms of the throw of the eccentrics? D. Y.

Ordinarily, the radius of the Stephenson link should be made equal to the length of the eccentric rods reckoned from the center of the eccentric. Without a rocker the radius may be greater and with a rocker it may be less, but deviation from the normal should not be enough to derange the leads. The eccentric rods should be twelve times the eccentricity of the eccentrics and the operative length of link should be four times the eccentricity or more, if space is available, although a skillful designer may employ the inequality introduced by short rods or a short link to adjust a link motion.

Airbound Water-Supply Line—We have a 2½-in. gravity water-supply line about 1,000 ft. long that becomes airbound whenever the line is drawn upon during a few hours to its fullest capacity. How can the trouble be remedied? A. R. H.

Liberation of air results from reduction of pressure of the water, especially at high points in the line where excessive drafts produce a siphonage. The remedy would be to place vent-cocks in the top of the pipe at such points. The vents should be left open a very little all the time. If the slight waste of water is objectionable, it can be prevented by connecting the vents to small-sized standpipes extended higher than the level of the water in the supply reservoir.

Rotation Direction of Alternator—Does it make any difference which direction a newly installed alternator revolves? Or will the exciter connections to the alternator have to be reversed in case the generator is rotated in a direction opposite from that intended by the manufacturer? The exciter is driven from the alternator. E. G. H.

If the machine is operated as a single unit, it will not make any difference in which direction the rotor revolves. If the direction of the exciter is reversed, it will be necessary to cross either its armature or field leads so that the machine will generate. Where the alternator is operated in parallel with other machines care will have to be taken to see that the new machine has the proper phase relation to the bus voltage.

Feeding Return-Tubular Boiler Through Blowoff—What are the advantages and disadvantages of feeding a return-tubular boiler through the blowoff? G. A. B.

The single advantage of feeding a boiler through the blowoff is that it saves provision of a separate feed connection. The advantage sometimes claimed that, by feeding through the blowoff, the flow of feed water keeps the blowoff flushed of mud, is likely to be defeated by mud filling both blowoff and feed connection when there is intermission of feeding. In cases where the feed water contains impurities, like lime, that are precipitated by heat, feeding through the blowoff is likely to contribute to scaling up of the blowoff connection. Another disadvantage is that by feeding in bulk through a hole in the shell, the greater or less irregularity of discharging feed water at lower temperature than the temperature of the boiler water gives rise to differences of expansion that are injurious to the boiler. All these objections, except scaling and rusting of the feed pipe itself, are overcome by feeding through a pipe introduced through the shell above the fire line and carried thence for some distance through the boiler, so the feed water may be raised more nearly to the boiler temperature and then discharged at some distance from the shell or stays.

Fuel Oil Versus Mechanical Stokers*

By F. H. DANIELS

ALMOST all comparisons of the values of oil and coal consider the burning of fuel oil and the burning of hand-fired coal. It is the purpose of this article to show a comparison of fuel oil with coal burned on up-to-date mechanical stokers. Before making these comparisons it may be interesting to review very briefly a few of the facts regarding fuel oils.

The petroleum production of the world in 1917 was approximately 503,000,000 bbl. Of this amount 342,000,000 bbl. was furnished by the United States. In the United States up to 1918, we have used 4,250,000,000 bbl. of oil, and it is estimated that there remains 6,900,000,000 bbl. This calculation of the oil yet unused in the United States may be seriously upset by the discovery of new fields or by the utilization of the oil-bearing shales. All of the figures given are based on reports of the National City Bank of New York and of the United States Geological Survey.

The petroleum from the eastern fields of the United States has a paraffin base and is generally too valuable to use as fuel. The crude oils from the southwestern part of the country, however, have an asphalt base and after the

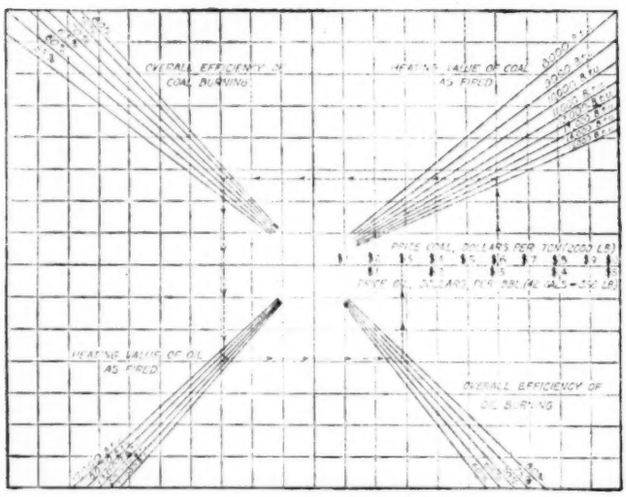

OVERALL EFFICIENCY OF COAL BURNING
HEATING VALUE OF COAL AS FIRED
PRICE COAL, DOLLARS PER TON (2000 LB.)
HEATING VALUE OF OIL AS FIRED
OVERALL EFFICIENCY OF OIL BURNING

CHART FOR COMPARING PRICES OF COAL AND OIL TO GIVE THE SAME EVAPORATION PER DOLLAR

gasoline, naphtha, benzine and kerosene are taken off, the residue is sold as fuel oil. In some cases the crude petroleum is burned without first taking off the naphthas. The total amount used as fuel equals about one-half the country's output. In general the United States has got to look to Mexico and Texas for cheap fuel oil.

If the cost of coal, its heating value in B.t.u. and the over-all efficiency at which it is burned are known, the accompanying chart shows the price at which oil will compete, considering the different heating value of the oil and the over-all efficiency obtainable with oil burning. The example worked out on the chart shows $6 coal, 14,000 B.t.u., 70 per cent over-all efficiency, as compared with oil at $1.45 a bbl., 19,000 B.t.u., and used with an over-all efficiency of 75 per cent. This chart takes into account only the cost of the two fuels and does not take into consideration costs such as labor, maintenance or the first cost of the plant. It should be noted that the heating values of both the oil and the coal are based on fuel as fired.

Taking 18,250 B.t.u. for the heating value of the oil and 14,000 B.t.u. for the corresponding heat content of the coal, we would have to burn 4.56 bbl. of oil to equal one ton of coal. This is assuming equal over-all efficiencies. The fuel-oil salesmen are claiming in New England as low as three barrels of oil to one ton of coal. This is absurd as it would require over 100 per cent over-all efficiency for the oil with 70 per cent for the coal.

The chief advantages claimed for the use of oil as compared with coal are as follows: High efficiency, high capacity, low labor costs, low first cost of equipment, no smoke, quick response to overload demands, less storage space required than coal, small amount of refuse, no banking losses. The disadvantages are: Fluctuations in price, uncertainty of supply, fire risk. The chief advantages claimed for fuel oil will be taken up one by one.

Stoker Efficiency as Good as That of Oil Burners

Of course, under the best of test conditions, fuel oil has shown over-all boiler efficiencies up to 82 per cent, and some tests show even above this. But the up-to-date mechanical stoker can show equally good results, and it is fair to assume that under average operating conditions the efficiency of furnaces using fuel oil will be no greater than that obtained with mechanical stokers burning coal of 12,500 B.t.u. and higher. This average efficiency would range from 65 per cent to 75 per cent, depending on the size of the plant, kind of coal or fuel oil used, the average rating at which the boilers are operated and the fluctuations in load. Of course, it must be remembered that there is good and poor fuel oil just the same as there is good and poor coal, although the range in the heating value of coal is more than that in the heating value of fuel oil.

Oil burners are much more subject to abuse on account of too much excess air than are stokers burning coal. If you try to give a coal fire too much air it will go out, but you can give an oil burner as much excess air as you please and there is no indication that this bad condition exists. The oil flame burns just as brightly, although you may give it three or four times the air required for best efficiency.

In connection with this question of efficiency, almost all land installations burning oil use high-pressure steam atomizers. The steam required amounts to about 2 per cent of the boiler output under ideal conditions, and it may go as high as 5 per cent. The steam required for operating stokers and the forced-draft equipment, if such is used, will be less than the corresponding figures for steam used by the oil burners. It should be remembered, also, that some of the heat from the steam used for stoker drive can be recovered by exhausting the stoker engines into feed-water heaters, while the steam used for oil burners is an absolute loss. If electric drive is used for stokers, the amount of steam taken from the boiler output will be much less, because the electric motors then share in the economy of the main prime mover.

Comparison of Capacities Is Not Unfavorable to Stokers

The capacities with a multiple-retort underfeed stoker will show higher than any that can be obtained with fuel oil. Most tests on fuel oil have been in connection with boilers where the furnace volumes were restricted. There have been no tests published where fuel oil has been used in connection with a furnace large enough to really enable the oil burners to show up to best advantage. It is safe to state, however, that with equal furnace volumes mechanical stokers will show higher capacities than are possible with oil.

As for labor, under proper conditions the mechanical stoker should not require more than one fireman and one water tender for every 5,000 hp. of boilers. It is impossible for a plant equipped with fuel oil to get along with a less number of men than this. As far as attending to the water level of the boilers is concerned, the labor involved is equal in each case, and the stoker does not require any more adjustment than would be needed for the manipulation of oil burners.

*Based on a paper read before the American Boiler Manufacturers Association.

Of course it must be admitted that the use of fuel oil practically eliminates the question of ash handling, but this is not a very serious factor because the amount of labor required for handling the ashes in an up-to-date plant is not very large and the class of labor is the lowest paid.

In connection with first cost of equipment the use of fuel oil avoids the necessity of the purchase of mechanical stokers and auxiliary equipment, which might range in cost from $8 to $14 per rated boiler horsepower. The fuel oil also avoids the necessity of coal- and ash-handling equipment, which would cost about $6 to $8 per rated horsepower. This would make a total of about $18 per horsepower. As an offset to these items fuel oil requires storage tanks, oil pumps and heaters, which will cost anywhere from $10 to $30 per horsepower, depending upon the amount of reserve oil which is to be kept in storage. For a central station of 5,000 horsepower the complete oil-burning equipment with storage tanks for five months' supply of oil has been estimated at $250,000, which would be at the rate of $50 per horsepower. An industrial plant could, of course, get along safely with much less than a five months' supply of oil on hand, but in almost any plant there will be little if any decrease in first cost in favor of fuel oil.

Smokeless Combustion Possible with Both Fuels

The mechanical stoker is every bit as good as oil burning as regards the feature of smoke. The air to the oil burners should be cut down for best economy so that a slight haze is emitted from the chimney. Additional air will stop the smoke completely, but it will be much in excess of the amount needed for combustion and will, of course, reduce the efficiency of operation. Some stoker installations can be criticized for carrying solid particles of finely powdered ash up the chimney, but as an offset to this the waste gases from a fuel-oil plant have an extremely unpleasant odor, which is very objectionable in thickly settled communities. It is also claimed that there is an oily residue which settles out of the gases from fuel-oil plants and that this residue is extremely hard to remove.

The underfeed stoker of today can raise a boiler from banked fire to 300 per cent of rating or more in from five to ten minutes. The plant with fuel oil cannot boast of any quicker response than this. The underfeed stoker can be shut down from high capacity almost as quickly, and would not compare unfavorably with the oil burner where it is merely necessary to stop the supply of fuel to shut down the boiler. In either case the heat stored up by the brickwork of the furnace is the limiting feature in time required to shut down.

Storage Space Requirements for Oil and for Coal

To compare storage-space requirements, we will assume an average calorific value for fuel oil of 18,000 B.t.u. per lb., and an average calorific value for bituminous coal of 13,500 B.t.u. per lb. The specific gravity of fuel oil will average about 0.95, which means that a cubic foot of the oil would have an average weight of 59.5 lb. A cubic foot of crushed bituminous coal will average about 52 lb. Therefore, for equal calorific values fuel oil will occupy only about two-thirds of the storage space required for coal. On board ship this is very important, but on land the fuel oil is stored in tanks and these tanks cannot be placed too close together on account of the insurance regulations. Coal, on the other hand, can be stored in one continuous pile, and the land occupied for the storage of fuel oil would amount to more than that required for storing an equal calorific value of coal.

While it is true that the burning of fuel oil leaves no ashes to be disposed of, there is the question of the residue which is deposited on the heating surfaces of the boiler. This residue is oily and extremely hard to remove and is highly nonconductive as regards heat. If it is allowed to remain on the boiler tubes, it reduces the economy of the installation materially. In order to remove this oil residue from the tubes, it is necessary to use steam soot blowers four or five times a day. This is more often than is necessary to remove the soot from the coal-fired boiler tubes and results in an extra amount of steam as compared with a coal-fired boiler.

In the case of a plant where fuel oil is used and where the load factor is low, there is claimed to be a considerable saving due to the fact that there are no banking losses. In the case of a stoker the coal consumption on a banked fire is approximately 30,000 B.t.u. per sq.ft. of grate surface per hour. With 14,000 B.t.u. coal this would amount to 2.15 lb. per sq.ft. grate surface per hour. If we consider a 500-hp. boiler with a grate surface of about 80 sq.ft., the coal used per hour would amount to 172 lb., or equal to 2,400,000 B.t.u. This heat, however, is not entirely a loss, because it serves to keep the furnace brickwork and the water in the boiler hot and ready to meet a sudden demand for steam. When the oil-fired boiler is shut down, the water and the furnace brickwork cool down and just that much more oil and time must be consumed to get the boiler into condition for steam generation. There is with oil some saving of banking losses, but under ordinary conditions this saving is not of any great magnitude.

Price and Supply of Oil Uncertain

Considering the disadvantages of oil, its price has been subject to tremendous fluctuations in the past, varying from 2.5c. per gal. in 1915 to a maximum of 7c. during the war period. The corresponding range of coal prices from 1915 to the war period would be, in the Pittsburgh district on run-of-mine steam coal f.o.b. cars, from $1 to $2. The fuel-oil market is more susceptible to disturbing influence than is the coal market. During the war practically all the fuel oil produced was used by the allied navies and there was hardly any surplus for land use. The merchant ships are now shifting over in large numbers to fuel-oil burning, and just as soon as any considerable percentage of them are changed over the price of fuel oil will rise. As shown later on in this paper, the supply of oil is limited and any large increase in use will send prices up.

Most of the fuel oil used under boilers in North America comes from California, Texas and Mexican fields. The history of Mexico for the last five or six years should be a good criterion for the possibility of interruption of supply in case any large amount of steam-generating stations adopt oil as their regular fuel. The southern fields of the United States can supply but small percentage of the fuel oil that would be needed in case it was generally adopted.

Insurance Requirements for Oil Storage

The fire underwriters make some quite stringent restrictions on the use of fuel oil. The oil must be stored underground in concrete or steel tanks and the top level of the oil must be below the level of the burners and pumped to the burners. Any gravity feed of the oil to the burners is prohibited on account of the risk of heating and subsequent explosion when the boilers are started up. If the oil cannot be stored underground on account of tidewater, ledge or any other reasons, it may be stored in concrete or steel tanks above ground, provided they are located 150 ft. away from the nearest building. Each tank must be surrounded by an earthwork or concrete dike of a capacity equal to one and one-half times the capacity of the tank. This is to catch the oil in case the tank should burst for any reason. The capacity is specified as one and one-half times the tank so as to allow for snow or rain water standing in the bottom of the dike. If for any reason the above-ground tank cannot be located 150 ft. from the building, it must be buried in earth above ground; that is, the earth must be piled up on the tank so as to completely cover it.

There is considerable danger of igniting the fuel oil from lightning discharges. All tanks should be provided with a steam-line connection for suffocating the fire, or some other form of fire extinguisher should be provided, such as carbon dioxide gas, foamite, etc. If all the foregoing precautions are taken and if the layout of the proposed oil-burning plant is submitted to the fire underwriters, for approval, there will generally be only a slight increase in the fire-insurance rates on adjacent buildings.

It is an interesting fact that many of the oil companies themselves burn coal under their boilers.

The ideal place to use fuel oil is on board ship, where the additional cargo space made available by the decreased

volume of the oil as compared with coal is of prime importance. The elimination of hand firemen is also important, because this releases for freight carrying the space formerly occupied by the firemen.

Edward N. Hurley, formerly of the United States Shipping Board, estimates the world's ocean tonnage before the war at 50,000,000 dead-weight tons, and he figures that this might increase to 75,000,000 within the next five or ten years. Roughly speaking, a boat requires a ton of oil yearly for every dead weight ton of ship. This applies to steam-driven vessels. The world's output of petroleum in 1917 was approximately 500,000,000 bbl. If all the 75,000,000 tons of ships were driven by fuel oil, it would take 450,000,000 bbl., or about 90 per cent of the world's production of petroleum. When you consider the large amount of the world's output of crude oil which is needed for refining to the higher-grade petroleum derivatives, it can be readily understood that if fuel oil were reserved for use on boats there would be no excess for burning on land under boilers. Of course boats driven by Diesel engines require only about half the quantity of oil that is needed for steam-driven vessels, but if all the shipping in the world were driven by this type of engine there would still not be any great excess of fuel oil for land use.

There are of course, many places besides on board ship where fuel oil ought to be used. Many special heating furnaces cannot be adapted for burning coal, and in many other instances oil is the logical fuel. The demand from these sources and from the shipping interests combined and a scarcity of supply has even now put the price of fuel oil up to over twelve cents a gallon. This price puts oil out of the question as a competitor of coal for general power uses. Of course, fuel oil will always be used for certain purposes where it is especially convenient, but this article is intended to show that it will never replace coal where coal can be burned efficiently on modern mechanical stokers.

Safety First for the Engine Room

By Frederick L. Ray*

Of first importance is the emergency over-speed devices for engine and turbines. They should be tested once each day for over-speed to know that they are in working condition. Many wrecks of engines and turbines are prevented by close inspection and test of these devices.

Relief valves on cylinder, receivers and turbines must be kept in working condition, which can be done by testing them once each month with steam, closing exhaust valves and having provided a pressure gage.

Regular periodic inspection of all apparatus must be carried out at not longer intervals than twenty minutes. This will prevent hot bearings and save many a nut coming off and some part breaking.

Governor belts must be kept in first-class condition. Don't keep them in service too long; you may wreck an engine by getting the last day's service out of a belt. You had better put a new one on the engine and use the old one in some less important place. Some terrible engine wrecks have been caused by failures of governor belts.

Vacuum breakers on condensers must be kept in good order for the protection of the engine or turbine. A flooded condenser will quickly wreck an engine or turbine.

A noiseless engine is a fair indication that it is in safe working condition. Every blow that a noisy engine makes is one more nail in its coffin, for every piece of metal will withstand but so many blows before breaking.

Emergency oil lamps should be kept trimmed and at night should be kept burning but turned low. If the station lights fail, you will need the oil lamps quickly.

Valves must not be left jammed or locked, either open or closed, but left in condition so that in case of emergency they can be moved easily in either direction. In case of accident you may not find a bar quickly.

Air-compressor receivers are dangerous if not properly cared for; keep them well blown out of water and oil. Many a receiver has been exploded, owing to the ignition of oil in them.

Keep all openings in floor well guarded with railing if a permanent opening, or if a temporary opening, then with covering that will prevent anyone from stepping into them.

Keep fire pumps ready for operation; you may need them the next minute.

In case of accident to the machinery, go slow, stop, look and listen. You will then be able to do the right thing. Courage is needed at times about a power house, but courage is only brute force and when compounded with ignorance is dangerous. Keep cool and be sure you know what you are doing.

After a job of work is finished, be sure you have all the tools and that none are left so that they will fall into machinery.

*In *Safety*, house organ of the Union Traction Company of Indiana.

In Charge of the Engineers

By William H. Woodwell

Half a point, half a point,
Half a point upward,
Seeking efficiency—
  All of one hundred.
Forward the engineers,
Brilliant are their careers,
Seeking the maximum,
  Seeking one hundred.

Forward the engineers!
Never a man dismayed
Even though others
  Have stumbled and blundered.
Theirs is to reason why
Charges and costs are high,
Theirs is to do or die,
  Seeking one hundred.

Meters to right of them,
Gages to left of them,
Readings in front of them,
  Tabled and charted.
Working on curves and plots,
Formulas, ohms and watts,
Finding the wasteful spots;
  Never faint-hearted.

Problems to right of them,
Problems to left of them,
Problems before them;
  We have all wondered,
If they can scale the peak,
Stopping each waste and leak,
Attaining the goal they seek,
  Reaching one hundred.

Where can their glory fade?
Oh, the advance they made!
  Steady progression.
Honor the part they played,
Honor the gain they made;
  Noble profession. —*Ideal Power*

An undergraduate course of training in Electric Communication Engineering is to be established at Harvard University, Cambridge, Mass., and two new courses will be substituted for the present course in Sanitary Engineering. This is being done with the object of giving more advanced instruction to prospective public engineers and sanitary chemists.

Admiral William S. Benson, chairman of the Shipping Board, announced at the ninth annual dinner of the Marine League on April 14, New York City, that he proposed to develop the Diesel engine and electric drive during his administration as he was convinced that the electrically driven ship is far superior in performance to the steam-driven vessel.

Study Course for the Coal Trade

A study course primarily for coal salesmen has been perfected by W. D. Langtry and Osborn Monnett of the Commercial Testing and Engineering Co., Chicago. The plan is to give sufficient instruction on boiler-room problems so that the coal salesman can talk intelligently with the chief engineer, superintendent or manager of the plant about the actual merits of his coal under burning conditions. A salesman in the power-plant trade should know what takes place in the boiler room and should be familiar with the burning characteristics of the fuel he sells under various operating conditions. The course will give him all this. It is to begin the latter part of April, and there will be sessions one night each week for ten weeks. It will be elementary in character and made practical by visits to plants for demonstration purposes. Coal versus oil, in which the relative advantages and disadvantages of both types of fuel will be discussed and data given concerning oil supply, consumption, delivery and contracts. The combustion of coal will be given thorough consideration and distinction will be made between coal for low-pressure plants, coal for hand-fired high-pressure plants and coal for stoker-fired plants. There will be visits to typical plants to witness evaporative tests, and the student will be shown how to figure the test, how to take coal samples and compute the cost of generating 1,000 lb. of steam. The characteristics and typical analyses of competitive coals on the Chicago market will be given, and there will be other data including freight rates on these coals, commercial considerations, etc. Methods of mining and their relation to the dealer will be given consideration, and there will be information on the preparation, sizing and washing of coal and suggestions on better methods of storing to prevent spontaneous combustion. The final lecture of the series will be devoted to the selling of coal. It will tell how to interpret analyses, how to transfer from a commercial to a dry basis and vice versa, how to calculate the net B.t.u. for one cent and delivered values, how to bid on B.t.u. contracts and tonnage contracts, with suggestions on what to avoid in these operations.

Although the primary intention is to educate the coal salesman, the course will be of such a practical character that it should interest also the power-plant operator, or in fact anyone connected with the purchase and burning of coal under a steam boiler.

Comparison of British and American Coal-Mining Conditions

A recent article appearing in a British journal points out that the American miner produces 2½ times as much coal per shift as the British miner, at one-half the cost, and proceeds to explain the natural industrial and engineering causes that lead to this result. Among the reasons given for this inequality is the greater depth at which the British coal mines are necessarily worked, and the small proportion of thick seams of coal, which has its effect on the methods of removal and transportation. A second reason is given as the fact that coal mining in America is regarded as a low-class industry, and that the large number of miners employed underground are agricultural emigrants. A third cause assigned for cheaper coal and mining in the United States is that the industrial conditions in this country have rendered it easy for the operators to introduce and satisfactorily operate coal-mining machinery to a greater extent than is possible in Great Britain.

George F. Rice, chief mining engineer of the United States Bureau of Mines, in a recent report, takes exception to most of these reasons. He points out that conditions in America result in the bed of coal being worked more rapidly, so that the average mine haul is far greater here than in the British collieries. On the other hand, it is admitted that the British haul is more difficult, owing to the greater vertical lift necessary and also to the fact that trolley locomotives are forbidden in British mines on account of the danger of sparking. Regarding the class of laborers employed, Mr. Rice points out that while the labor in the United States mines is, to a large extent, low-grade, yet these emigrants receive double or triple the wages of British miners. He also points out that the question of machinery in coal mining would not entirely make up for the difference in cost, as there are numerous examples in this country of hand-worked mines and machine-worked mines side by side competing with each other. Mr. Rice seems to think that the largest part of the difference between the cost of mining in the two countries is due to the much greater depth at which coal is found in Great Britain. He considers further that the natural advantage enjoyed by the United States in this respect will not be lost, as the coal in the large mining districts in America is all easily accessible, and mining at very great depths will not be necessary until practically the entire Appalachian, Central and Interior fields are worked out, and these should last at least as long as the British fields.

Economizer Expert Addresses Heating and Ventilating Engineers

A paper on "Economizers" was read by W. F. Wurster, of the Green Fuel Economizer Co., before the Eastern Pennsylvania Chapter of the American Society of Heating and Ventilating Engineers, at the Engineers Club, Philadelphia, on the evening of April 8. Mr. Wurster described briefly the first type of machine, and with the aid of lantern slides explained the details of the modern apparatus, giving some interesting data on economizer performance.

The economizer was first used in 1845 by Edward Green. It consisted of a circular group of 30 cast-iron tubes 4 in. in diameter and 9 ft. long, connected at the top and bottom to hemispherical chambers. The cold water was introduced into the lower chamber and, after rising through the tubes, passed to the boiler. This apparatus heated water to the boiling point and at times formed steam which was allowed to escape through a safety valve at the top.

After a few weeks the temperature of the water leaving the economizer became lower and the draft was impaired. On removing the brickwork inclosing the machine, the gas passage was found to be choked with soot which was killing the draft and insulating the tubes. This led to the design of mechanical scrapers to continuously scrape the soot from the tubes.

From this beginning has developed the modern economizer, which is built in sections, each of which is made up of a top and bottom header connected by the necessary tubes. The number of sections is always a multiple of four since each chain wheel operates the scrapers for four sections. Sections have from four to twelve tubes each, which vary from 6 to 12 ft. in length and are 4¼ in. in diameter. In modern installations the walls of the economizer chamber are made up of removable steel plates instead of brick. This facilitates inspection or repairs.

In proportioning the economizer and in figuring the possible savings by its use, the most important factors are the temperature and quantity of gases available, the initial temperature and quantity of feed water and the available draft. Mr. Wurster gave some values to be used as guides in making such calculations. The flue-gas temperatures from boilers run at 100 per cent of rating vary from 475 to 550 deg. F., at 150 per cent of rating from 525 to 600 deg. F., and at 200 per cent from 575 to 675 deg. F.

The amount of gas available per boiler horsepower per hour from oil-burning furnaces is about 50 lb., from underfeed stokers about 60 lb., from hand-fired furnaces with good firing about 80 lb. and with ordinary hand-firing from 90 to 100 lb. It is, of course, understood that these values are only approximate and are subject to considerable variation.

The amount of economizer surface installed varies from about 3 to 7 sq.ft. per boiler horsepower. Curves were shown to illustrate the fact that the more surface installed, the greater is the feed-water temperature rise, the lower

the final flue-gas temperature, the greater the loss in draft and the higher the cost of apparatus. In designing an economizer installation, the first two items must be balanced against the last two, taking into consideration the specific conditions in the particular plant under consideration.

In answer to questions from the floor, Mr. Wurster explained that cast-iron tubes were used rather than wrought-iron or steel, owing to the corrosive action of water on the latter metals at the temperatures met in economizer work. He claimed, however, that cast-iron tubes have been satisfactory even at modern boiler pressures, and that practically all explosions of economizers had been due to abuse rather than to the use of cast iron.

Present High Prices of Bituminous Coal

Herbert N. Shenton, secretary of the United States Bituminous Coal Commission, in a formal statement recently, characterized the present high prices of bituminous coal as inexcusable on any theory of supply and demand or on any economic principle. Mr. Shenton pointed out that the fear of a coal shortage, on account of the export to meet foreign demands, was groundless, since the physical facilities for handling export coal would limit its amount to about 2 per cent of our total production. Based on the reports of production in the first quarter of the present year, there seems to be no reason for a fear that the production will be below the demand. It is evident that there has been considerable apprehension of a car shortage, but while there is definite need for more car and motive power, there is no immediate threatening of a car shortage such as would reasonably account for the rise in prices.

Mr. Shenton lays considerable emphasis on the claim that the rise in price can in no way be attributed to the campaign for early buying and storage, as recommended by the Coal Commission. This recommendation urged an increased buying of coal beginning on or about May 15, when, at the present rate of production, there was reason to believe that production would be in excess of market demand.

Among the reasons given as helping the upward trend in prices are the fact that a rearrangement in the distribution of coal was necessary after April 1; that the first week in April happened to include the low production period always associated with Easter, and that high cost production mines, which have for past years been able to operate only because of fixed price conditions, are making a last effort to obtain what they can. In concluding, Mr. Shenton states that frenzied bidding up of prices on the part of coal buyers seems at this time to be entirely unjustified. There is every reason to believe that the present high rates will be temporary.

Superheating Wet Steam

It is sometimes stated that the function of the superheater is first of all to dry the steam that comes to it wet from the boiler, and then to raise its temperature through a prearranged number of degrees above that which obtains in the boiler. This, however, is an erroneous point of view, for according to the amount of wetness with which the superheater has to deal, so is its efficiency as a superheater reduced and so, in consequence, is the efficiency of the engine reduced. Thus, considering boiler steam at 200 lb. per sq.in. gage pressure, its latent heat is about 838 B.t.u. per lb., so that 1 per cent of moisture requires 8.38 units of heat in the superheater to dry it. Hence, taking the specific heat of superheated steam as 0.55 B.t.u. per lb. per degree Fahrenheit, this amount of heat is capable of raising the temperature of steam through about 15 deg. F. Thus, if the boiler is fitted with a superheater capable of giving 100 deg. F. of superheat, if the steam enters the superheater containing only 3 per cent of moisture the superheat would be reduced to 55 deg. F., while the superheat would be entirely eliminated if the moisture in the steam reached about 7 per cent. When it is remembered that the steam consumption of the engine may be considered as being reduced by about 1 per cent for every 10 deg. of superheat, it will be seen how great is the effect of moisture in the superheater on the steam consumption of the engine. While, of course, under ordinary circumstances it is impossible to prevent wet steam from passing from the boiler, it is obviously of the greatest importance that steps should be taken by fitting anti-priming pipes or separators to insure that the steam entering the superheater is as dry as possible.—*Shipbuilding and Shipping Record.*

Propose to Operate U. S. Nitrate Plants

United States Nitrate Plants Nos. 1 and 2, located at Sheffield and Muscle Shoals, Ala., were constructed during the war for military purposes. Particular efforts were made to make the plants up to date and complete in every way. At the time of the signing of the armistice, plant No. 1, using the synthetic ammonia process, was merely in the experimental stage; plant No. 2, using the cyanamide process, was about ready to start production. Complete descriptions of the power equipment of these installations are given in the March 25 and the June 24, 1919, issues of *Power*.

In order to insure the peacetime operation of our nitrate plants for the production of nitrogen fertilizer compounds for agricultural purposes and also render available a source of nitrogen for military purposes in case of emergency, a bill has been placed before the Senate Committee on Agriculture and Forestry, authorizing the establishment of the United States Fixed Nitrogen Corp., the stock to be owned by this corporation, to purchase and operate the two nitrate plants for the aforementioned purpose. It is estimated that $12,500,000 will be needed to finance the proposed corporation. In order to raise the required amount it is planned to sell half the reserved stock of Chilian nitrate now held by the War Department.

The suggestion incorporated in the bill to take over the plants is to use plant No. 1 to further development and research in the art of nitrogen fixation and No. 2 will be operated for the production of appropriate nitrogen compounds.

Power-Plant Construction in Korea

The rich gold deposits in Korea, about twenty years ago, led to the granting of mining concessions to the Oriental Consolidated Mining Co., an American corporation. In order to place the mining operations on a paying basis, it was found necessary to secure additional hydro-electric power and the Kuron (Nine Serpents) River, twenty-five miles from the mines and about thirty miles from the South Manchuria R.R., was chosen.

A dam 650 ft. long and 34 ft. high, with foundations extending 15 ft. below the water level, and a diversion tunnel 955 ft. long were constructed. Two Pelton-Doble turbine units, each with a capacity of 800 hp., were installed and connected, by two short steel penstock pipes, 6 ft. in diameter, with the tunnel. Six hundred kilowatt G. E. generators, with a capacity of 2,300 volts, were installed. This was transformed to 23,000 volts for transmission over a twenty-five mile pole line to the mines.

The construction of power houses, dam and tunnel and the installation of the equipment was a difficult and slow task. Materials for the construction of building and heavy machinery were transported wherever possible by boat and by coolies. Cement was brought in by bull cart from the South Manchurian R.R., 35 miles away. The coolie packer is capable of carrying as much as 700 lb., and a number of these men were used to transport the frames weighing 2,500 lb. over the mountains to the power house site.

The plant, which was started early in 1918, was finally finished in November, 1919, and is in successful operation. The total water-power development in Korea is now about 2,000 kw., and two of the three completed plants are controlled by the Oriental Mining Company.

New Publications

EXAMPLES IN HEAT AND HEAT ENGINES, by T. Peel, M. A., Demonstrator in Engineering, Cambridge University. Published by the University Press, Cambridge, England. Paper; 5½ x 8¼ in.; 104 pages. Price, $1.50.

This pamphlet is a collection of questions and problems taken mostly from examination papers for the courses of lectures in Heat Engineering at the Cambridge Engineering Laboratory. The questions are arranged in groups or "Papers," becoming more difficult toward the end of the collection. Answers are given on the last pages for all problems. Students of heat engineering who desire a variety of problems for drill, or instructors looking for problems for class assignment or examination papers should find this collection useful.

Obituary

Frank M. Babcock, engineer of the Veazie hydro-electric station of the Bangor (Me.) Railway Co., since it was built, forty years ago, died April 13, after a short illness, at the age of seventy-five. Mr. Babcock contracted a cold which developed into pneumonia. He is survived by his widow and a daughter.

Personals

Maxwell C. Maxwell, formerly assistant general superintendent of the Yale & Towne Manufacturing Co., has been appointed to the position of general superintendent.

Norman Taylor, representative of the Hagan Corporation of Pittsburgh, Pa., is located at the Wolcott Hotel, West Thirty-fourth Street, New York City, until he can secure permanent offices.

M. W. Eastman, chief engineer of the Charlestown power house of the Boston Elevated R.R., has been transferred to the Lincoln Station. Atlantic Ave., and R. H. Dixon, formerly at Lincoln Station, has been transferred to Charlestown.

Ralph G. Macy has resigned his position as chief engineer in the construction department of the Walter Riddle Co., New York, and is now associated with the Engineering and Appraisal Co., Inc., of New York.

F. H. Ballou has resigned his position as assistant chief engineer of the Great Western Sugar Co., Billings, Mont., and is now with the Amalgamated Sugar Co., Ogden, Utah, in the capacity of chief engineer.

Charles F. Lang, president of the Lakewood Engineering Co., Cleveland, Ohio, was elected president of the Material Handling Machinery Manufacturers' Association, New York, at a recent meeting of the directors.

Frank D. Randolph, formerly with the Kelly Press Department of the American Type Foundries Co., Jersey City, N. J., is now associated with the Premier & Potter Printing Press Company, Inc., Plainfield, N. J.

William F. Mahoney, formerly captain, Ordnance Department, U. S. A., announces that he has resumed the practice of patent and trade-mark law with offices in the Washington Loan and Trust Building, Washington, D. C.

A. Pohlman, formerly connected with the Badenhausen Co., New Haven, Conn., has resigned and is now connected with J. S. & J. F. String, engineers and contractors. Mr. Pohlman will give particular attention to the design and supervision of fuel-oil apparatus.

William J. Beswick, formerly boiler inspector for the Hartford Insurance Co. and during the war chief engineer on the United States transport "Everett," has accepted the appointment of chief engineer at the American Linen Co.'s mills in Fall River, Mass.

A. L. Kempster, former manager of the Puget Sound Light and Power Co. until the city recently obtained possession of the street-railway lines, has accepted the position of manager of the New Orleans Railway and Light Co., now in the hands of a receiver.

Clifford H. Peters, of Cleveland, Ohio, formerly a captain attached to the Engineering Division, Ordnance Department, U. S. A., has opened an office at 226 Superior Avenue, West, Cleveland, where he will practice mechanical consulting engineering, including the design and construction of various types of automatic and semiautomatic machines, plant layouts, production systems, etc.

Society Affairs

The American Society of Civil Engineers, Philadelphia Section, will hold its regular meeting on May 3.

The Association of Iron and Steel Electric Engineers, Philadelphia Section, will meet on May 1. The meeting will be open for general discussion.

The New Haven Branch, A. S. M. E., will hold a meeting on May 12. Subject: "Airplanes," by a speaker from the Gallander Corporation.

The American Association of Engineers will hold its annual convention at St. Louis, Mo., May 10 and 11. The headquarters for the convention will be at the Planters Hotel.

The New Jersey State Association, N. A. S. E., will hold its annual convention and mechanical exhibit at Phillipsburg, N. J., June 2 to 6 inclusive. A charge of twenty dollars will be made for each booth.

The Amerian Institute of Electrical Engineers, Philadelphia Section, will meet on May 10. A paper will be presented by the Students' and Graduates' Engineers' Club on "Professional and Financial Aspect of Electrical Engineers."

The American Association of Engineers, Kansas State College Chapter, has elected the following officers for 1920: Walter E. Dickerson, president; C. H. Scholer, vice president; H. Kenneth Shideler, recording secretary; Paul G. Martin, treasurer.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hold a meeting on May 1. Members are given the privilege of preparing papers on a subject pertaining to the application of electricity to the iron and steel industry.

The New York Section of the American Association of Engineers recently introduced a bill in the New York State Legislature providing for the licensing of engineers. The bill was passed April 15 by the Senate and will immediately be introduced into the Assembly.

The Chamber of Commerce of the United States will hold its eighth annual meeting at Atlantic City, April 26 to 29. Representatives of more than thirteen hundred commercial and industrial bodies will be present for a thorough discussion of ways and means of increasing production.

The American Railway Engineering Association has become a member society of Engineering Council. The association has about 1,650 members, and its headquarters are at 431 South Dearborn St., Chicago, Ill. The representative of the association upon Engineering Council will be its president, Mr. Safford, who is a member of the American Society of Civil Engineers and the Engineering Institute of Canada.

The Industrial Relations Association of America will hold its second annual convention at the Auditorium Theater, Chicago, Ill., May 19-21. Every phase of the industrial situation will be covered by the presentation of papers by men representing each industry. Section and subject meetings will be held between the main sessions, these being devoted to some particular branch of industry and industrial relations work.

The National District Heating Association will hold its eleventh annual convention at the Hotel La Salle, Chicago, Ill., May 25-27. Prof. John R. Allen will deliver a paper on "Heat Losses from Underground Pipe." Prof. J. D. Hoffman on "Technical School Training for the Heating Profession," and R. V. Stureman on "Advantages and Disadvantages of Steam and Hot Water Heating." A paper on "Bleeder Turbines in Heating Service" will be presented.

Miscellaneous News

The Kansas City Power and Light Co., Kansas City, Mo., is planning to take over the system of the North Kansas City Light, Heat and Power Co. The system is valued at $150,000.

The Utica Gas and Electric Co., at its recent annual meeting elected the following officers: Frank M. Tait, president and general manager; F. B. Steele and M. J. Brayton, vice presidents; George H. Stack, treasurer; William J. McSoiley, auditor. The following directors were chosen: Frank M. Tait, S. A. Beardley, W. E. Lewis, C. S. Symonds, C. B. Rogers, N. F. Brady, W. T. Baker, M. J. Brayton and William L. Taber. The stockholders at the same meeting voted to increase the capital stock from $4,500,000 to $8,500,000.

Business Items

The Electric Storage Battery Co., 100 Broadway, New York City, announces the removal of its offices to the National Association Building, 21-31 West 43rd St., New York.

The Roller-Smith Co., 233 Broadway, New York City, announces the removal of its Cleveland office from the Williamson Building to the Vickers Building, 65th Street and Euclid Avenue.

The Yale & Towne Manufacturing Co., New York, announces the removal of its general offices to Stamford, Conn. The change was made in order to consolidate the selling organization with the factory.

The Westinghouse Electric & Manufacturing Company announces the formation of a Marine Division in its offices at 165 Broadway, New York. The object of the new department is to give advice in the selection of ship propulsion machinery. The work will be in charge of Norris R. Sibley, formerly chief engineer, U. S. Army Transport Service, and Frank F. Boyd, chief engineer of the U. S. S. "Jupiter."

Trade Catalogs

The Griscom-Russell Company, 90 West Street, New York City, has just completed the publication of a new fifteen-page booklet entitled "Stratton Steam Separator." Bulletin No. 1140. The booklet shows by means of illustrations the various types of steam regulators manufactured by this company, and gives complete instructions on construction and operation. A copy will be sent on request.

The A. M. Byers Co., of Pittsburgh, Pa., has recently issued a 32-page bulletin No. 38, on "Installation Cost of Pipe." The bulletin gives detailed information on the cost of the installation and upkeep of pipe. The main object of the publication is to bring out the relation of the installation cost to the cost of pipe that goes into the system. With this end in view a series of cost analyses covering twenty different pipe installations and practically every class of pipe system are shown by means of charts and diagrams. The booklet should prove of value to operating and consulting engineers, who will find in it information not obtainable elsewhere. Copies sent on request.

The Deming Company, Salem, Ohio, has isued Catalog No. 26, "Hand and Power Pumps." Cloth, 6 x 9 in.; 254 pages. The book describes various pumps and apparatus manufactured by the Deming Co. In addition to this a number of clear, concise tables and information relating to hydraulics have been prepared, which should prove useful to dealers in pumps. The catalog is arranged in chapters and sections, grouping each distinct class of pumps or accessories separately, so that by referring to the table of contents one can quickly find any particular article shown. The chapter devoted to miscellaneous hand and power pumps describes in detail apparatus for the farm, factory, garage, plumbing shop, etc. A complete description of each article is given, eliminating the necessity of correspondence for information.

COAL PRICES

Prices of steam coals both anthracite and bituminous, f.o.b. mines, unless otherwise stated, are as follows:

ALANTIC SEABOARD

Anthracite—Coals supplying New York, Philadelphia and Boston:

	Mine
Pea	5.30
Buckwheat	$3.40@$3.75
Rice	2.75@ 3.25
Barley	2.25@ 2.50
Boiler	2.50

Bituminous—Steam sizes supplying New York, Philadelphia and Boston:

Latrobe	$4.25@$4.50
Connellsville coal	4.25@ 4.50
Cambrias and Sunset	4.25@ 4.85
Clearfields	3.75@ 4.50
Pocahontas	6.50@ 7.00
New River	6.50@ 7.00

BUFFALO

Bituminous—Prices f.o.b. Buffalo:

Pittsburgh slack	$6.25@$6.50
Mine-run	6.25
Lump	6.25@ 6.50
Youghiogheny	6.25

CLEVELAND

Bituminous—Prices f.o.b. mines:

No. 6 slack	$3.25@$4.00
No. 8 slack	3.50@ 4.00
No. 8—¾-in.	3.50@ 4.00
No. 6 mine run	3.50@ 4.00
No. 8 mine run	3.25@ 4.00
Pocahontas—Mine-run	3.25@ 4.00

ST. LOUIS

Anthracite—Probably not more than 20 per cent of the demand in this market can be supplied. Prices effective Apr. 1 were as follows:

	Williamson and Franklin Counties	Mt. Olive and Staunton	Standard
Mine-run	2.65@2.80	2.65@3.00	2.65@2.80
Screenings	2.50@2.65	2.50@2.65	2.50

Williamson-Franklin rate to St. Louis is $1.10; Other rates 95c.

CHICAGO

Bituminous—Prices f.o.b. mines:

		Freight rate
Illinois		
Southern Illinois		
Franklin, Saline and Williamson Counties		Chicago
Mine-Run	$3.00@$3.10	$1.55
Screenings	2.60@ 2.75	1.55
Central Illinois		
Springfield District		
Mine-Run	$2.75@$3.00	$1.32
Screenings	2.50@ 2.60	1.32
Northern Illinois		
Mine-Run	$3.50@$3.75	$1.24
Screenings	3.00@ 3.25	1.24
Indiana		
Clinton and Linton		
Fourth Vein		
Mine-Run	$2.75@$2.90	$1.27
Screenings	2.50@ 2.65	1.27
Knox County Field		
Fifth Vein		
Mine-Run	$2.75@$2.90	$1.37
Screenings	2.50@ 2.60	1.37
Brazil Block	$4.25@$4.50	$1.27

New Construction

PROPOSED WORK

N. H., Laconia—The Bd. Educ. will soon award the contract for the construction of a 2 story, 70 x 180 ft. high school. A steam heating system will be installed in same. Total estimated cost, $225,000. P. S. Avery, 95 Milk St., Boston, Mass., Archt.

Mass., Ashland—MacNaughton & Robinson, Archts., 101 Tremont St., Boston, will soon award the contract for the construction of a 3 story, 65 x 65 ft. manufacturing building and power house on Pleasant St., for the De Swett Root Beer Inc., 10 P. O. Sq., Boston. A steam heating system will be installed in same. Total estimated cost, $40,000.

Mass., Boston—Lawrence & Wamboldt, Archts., 6 Beacon St., plans to build a 5 story, 100 x 100 ft. cooler building for meats, on South Market St. A steam heating system will be installed in same. Total estimated cost, $55,000. Owner's name withheld.

Mass., Wrentham—The Commonwealth of Massachusetts, c/o Kendall, Taylor & Co., Archts., 93 Federal St., Boston, plans to build a 1 story, 50 x 70 ft. cold storage building and a 1 story, 40 x 90 ft. industrial building. Total estimated cost, $88,000.

N. Y., Binghamton—The Bd. Educ. plans to repair and construct additions to the heating, lighting and plumbing systems in the public schools. Total estimated cost, $94,950. Address Daniel J. Kelley, Bd. Educ., Supt.

N. Y., Brooklyn—The Curb Holding Co., c/o Frank S. Parker, Archt. and Engr., 44 Court St., is having plans prepared for the construction of a 12 story, 134 x 135 ft. office building on Washington St. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., Brooklyn—B. W. Dorfman, archt., 26 Court St., is preparing plans for the construction of a 12-story, brick, steel and stone office building on Joralemon St. near Court St. A steam heating system will be installed in same. Total estimated cost, $500,000. Owner's name withheld.

N. Y., Dunkirk—The Atlas Crucible Steel Co., Howard St., plans to increase the size of its plant. Plans include the construction of a 40 x 140 ft. transformer building, etc. Total estimated cost, $1,800,000.

N. Y., Jamestown—The Common Council plans to construct a heating plant for the Jones General Hospital. Estimated cost, $22,000.

N. Y., Hamilton—The village has sold the electric lighting plant to the White Co., Norwich, cost $70,000. The company plans to build additions and extensions and install new generating equipment.

N. Y., New Berlin—The Berholme Power Co., Inc., plans hydro-electric development on the Unadilla River, to include a power house, generating unit and transmission lines. Total estimated cost, $19,900. The company has applied to the Pub. Servc. Comn. for permission to issue $25,000 bonds.

N. Y., New York—The Beth Hamedrast Shaapey Zion Inc., 46 West 46th St., is having plans prepared for the construction of a 2 story, 48 x 150 ft. synagogue and school on 178th St. A steam heating system will be installed in same. Total estimated cost, $250,000. I. J. Levy, Pres. L. A. Abramson, 46 West 46th St., Archt. and Engr.

N. Y., New York—The Church of Christ Scientist, c/o B. E. Muller, archt., 477 5th Ave., is having plans prepared for the construction of a 79 x 95 ft. church on Anthony Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., New York—The Combustion Eng. Corp., 11 Bway., will construct an 8-story office building at 43-47 Broad St. A steam heating system will be installed in same. Total estimated cost, $500,000. Ludlow & Peabody, 101 Park Ave., Archts. and Engrs.

N. Y., New York—W. A. Hefner, 465 10th Ave., is in the market for one 220 volt, d.c., unit motor blower fan.

N. Y., New York—I. Miller & Sons, care of Schwartz & Gross, Engrs., 347 5th Av., plan to build a 12 story loft building on 46th St. and 5th Ave. A steam heating system will be installed in same.

N. Y., New York—The New York Edison Co., 103 East 15th St., plans to build a 1 story sub-station on Cedar St. Estimated cost, $75,000. William Whitehill, 12 Elm St., Engr.

N. Y., New York—The Post Graduate Hospital, 2nd Ave. and 20th St., is having sketches prepared for the construction of an 11-story addition. A steam heating system will be installed in same. Howells & Rogers, 367 Lexington Ave., Archts. and Engrs.

N. Y., New York—J. Samuels, c/o Benjamin W. Levitan, Archt. and Engr., 7 West 45th St., is having plans prepared for the construction of a 13 story, 50 x 100 ft. store and salesroom at 6-8 East 30th St. A steam heating system will be installed in the same. Total estimated cost, $400,000.

N. Y., Rossie—George N. Wilson has made application to the Pub. Servc. Comn., for permission to construct and operate an electric lighting plant, here. He plans about 500 hp. hydro electric development on the Indian River.

N. Y., Salamanca—The Salamanca Panel Co. plans to install a 200 hp. electrically driven plant, and is in the market for two 50 hp. motors, one 15 hp. motor, five 10 hp. motors and several 5 hp. motors.

N. J., Atlantic City—C. F. Pabst, 396 Franklin Ave., Brooklyn, N. Y., plans to build a 4 story, 75 x 200 ft. sanitarium. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. J., Newark—The Newark Bd. of Trade, 800 Broad St., plans to build a 10 story office building on Branford and Treat Sts. A steam heating system will be installed in same. Total estimated cost, $500,000. Guilbert & Betelle, 2 Lombardn St.,, Archts. and Engrs.

N. J., Verona—The Essex Co. Hospital for Tubucular Diseases, will soon receive bids for the construction of a hospital. A steam heating system will be installed in same. Total estimated cost, $350,000. Jordan Green, Essex Bldg., Archt.

Pa., Harrisburg—Silberman Bros., 445 South 2nd St., are in the market for 1 swinger for an electric hoisting engine, for a derrick.

Pa., Philadelphia—John M. Greene, 261 Drexel Bldg., is in the market for a first-class 20 hp., 220 volt, d.c. single drum contractor's hoist complete with solenoid brake, controller and resistance (new or used).

Md., Cumberland—The Crystal Laundry Co., Baltimore St., is having plans prepared for the construction of a 1 and 2 story, 130 x 284 ft. laundry, garage and power house on Baltimore St. Boilers, engines and piping will be installed in same. Total estimated cost, $200,000. T. W. Biddle, c/o Kelly Springfield Tire Co., Archt.

S. C., Columbia—The State Legislature, Columbia, has appropriated $50,000 for the installation of a new heating and electric plant in the State Capitol. S. W. Cannon, state electrician.

Ala, Birmingham—The Tennessee Coal, Iron & R. R. Co., B. M. Bldg., engaged Horace H. Lane, Engr., 2320 Dime Bank Bldg, Detroit, Mich, to prepare plans for the construction of a 1 and 2 story freight car shop. A steam heating system will be installed in same. Total estimated cost, $2,500,000.

La., Shreveport—Chester & Fleming, Engrs., 1111 Union Bank Bldg., Pittsburgh, Pa., are preparing plans for furnishing new high and low service pumps, distribution mains, clear water reservoir, etc., for the city.

Ky., Versailles—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until May 6 for the installation of a fire box heating boiler at the Post Office here.

O., Akron—The city will receive bids until April 28 for the construction of a 1-story, 25 x 25 ft., brick and concrete pumping station, at Fairlawn Heights; also for furnishing two 500,000 gal. capacity centrifugal pumps. Estimated cost, $75,000. M. Knowles, 716 Hippodrome Bldg., Cleveland, Engr.

O., Akron—The Hotel Co., c/o Henry & Murphy, Archts., 523 2nd Natl. Bldg., is having plans prepared for the construction of an 8 story, 135 x 186 ft. hotel on East Market and Cambridge Sts. A steam heating system and two 250 hp. boilers will be installed in same. Total estimated cost, $3,000,000. Mayer & Valentine, Bangor Bldg., Cleveland, Engrs.

O., Akron—Marcus Loew, 1111 Euclid Ave., Cleveland, is having plans prepared for the construction of a 1 and 3 story commercial and theatre building on Main and Bowery Sts. A steam heating system will be installed in same. Total estimated cost, $1,250,000. C. Howard Crane, 2325 Dime Bank Bldg., Detroit, Mich., Archt.

O., Alliance—The Alliance Bank plans to build a 6 story bank and office building. A steam heating system will be installed in same. Total estimated cost, $500,000. Walker & Weeks, 1900 Euclid Ave., Cleveland, Archts.

O., Chillicothe—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until May 6 for the installation of a new heating boiler at the United States Post Office here.

O., Cleveland—The Bd. of Co. Comrs., c/o., Joseph Menning, Court House, plans to build a 1 story market house. A steam heating and refrigeration system will be installed in same. Total estimated cost, $300,000.

O., Cleveland—Greible & Ebeling, Archts. and Engrs., East 11th and Chestnut Sts., are preparing plans for the construction of an 8 story, 100 x 150 ft. commercial and office building on East 6th St. and Hamilton Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. Owner's name withheld.

O., Cleveland—The Simmons Motor Car Co., 4400 Euclid Ave., is having plans prepared for the construction of a 3 story, 95 x 195 ft. garage and commercial building on East 30th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000. G. W. Drach, Union Trust Bldg., Archt. and Engr.

O., Cleveland—The Wade Park Co., c/o the East Gas Co., East 6th St. and Rockwell Ave., plans to build an 8 or 10 story, 200 x 225 ft. hotel on East 107th St. and Wade Park Ave. A steam heating system will be installed in same. Total estimated cost, $3,000,000.

O., East Cleveland—(Cleveland P. O.) The Bd. of Co. Comrs., c/o Joseph Menning, Court House, Cleveland, plans to build a 1 story market house. A steam heating and refrigeration system will be installed in same. Total estimated cost, $300,000.

O., East Cleveland—(Cleveland P. O.) The East Cleveland Hospital Comn. plans to build a 3 story, 90 x 250 ft. hospital on Euclid and Strathmore Aves. A steam heating system will be installed in same. Total estimated cost, $250,000. C. M. Osborn, City Mgr. A. M. Allen Co., 1900 Euclid Ave., Cleveland, Archt.

O., Lakewood—The Lakewood Market House Co., c/o W. R. Powell, Pres., 705 Rose Bldg., Cleveland, will receive bids until May 1 for the construction of a 2 story, 78 x 300 ft. market house at 11826 Detroit Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

O., Youngstown—The City is having plans prepared for the construction of a 2 story, 60 x 150 ft. hospital. A steam heating system will be installed in same. Total estimated cost, $250,000. C. F. Owsley, Mahoning Bank Bldg., Archt.

O., Youngstown—The 1st Natl. Bank is having plans prepared for the construction of a 15 story, 60 x 120 ft. bank and office building. Steam heating boilers will be installed in same. Total estimated cost, $2,000,000. Walker & Weeks, 1900 Euclid Ave., Cleveland, Archts.

Ind., Indianapolis—The Ross Power Equipment Co., 617 Merchant Bank Bldg., is in the market for two 75 or 100 kw., 240 volt, 60 cycle, 3 ph. belted generator or engine sets with switchboard and exciter; one 300-500 kw. 480-2,300 volt, 3 phase turbo condenser, one 1,000 kw., 480-2,300 volt, 60 cycle, 3 phase turbo condenser; two 500 hp., B. & W. or Sterling boilers; one 250 kw., 430 volt, 3 phase, 60 cycle, belted generator; two No. 10 or 12 gyratory crushers (gates preferred), one No. 9 and four No. 5 crushers; one 24 x 48 in. jaw crusher and one 24 x 48 in. or 60 roll crushers.

Ind., Terre Haute—The Union Hospital Executive Committee is having preliminary plans prepared for the construction of a 3 story hospital on 7th Ave. A steam heating system will be installed in same. Total estimated cost, $350,000. F. P. Fairbanks, Chn. Stratton & Snyder, 1110 Union Trust Bldg., Detroit, Archts.

Mich., Bay City—The Amer. Worsted Yarn Co., c/o D. L. Galbraith, plans to build a 4 story, 120 x 400 ft. yarn factory on Water St. Steam heating equipment will be installed in same. Total estimated cost, $300,000.

Mich., Cedar Banks (Lansing P. O.)—Mrs. George P. Wanty, Secy., will soon award the contract for the construction of 2 and 3 story training school buildings including 3 dormitory buildings, administration building, power house and laundry, for the Michigan State Training School for Women. A steam heating system will be installed in same. Total estimated cost, $500,000. E. A. Boud, Lansing, Archt.

Mich., Detroit—The Bd. of Fire Comrs., c/o G. J. Finn, Secy., Larned St., is having plans prepared for the construction of a 3 story, 90 x 120 ft. fire alarm station on Macomb and Hastings Sts. Steam heating equipment will be installed in same. Total estimated cost, $250,000. Donaldson & Meier, 1344 Penobscot Bldg., Archts.

Mich., Detroit—The Dept. of Pub. Wks., City Hall, plans to construct and equip 100 mi. of city electric railways with car shops and power houses. Total estimated cost, $15,000,000. $1,000,000 of which will be used for buildings and equipment. A $15,000,000 bond issue for this project has been voted upon.

Mich., Detroit—Hugo Scherer, c/o Louis Kamper, Archt., Book Bldg., is having plans prepared for the construction of a 10 story, 53 x 141 ft. office and loft building on Woodward Ave. and Sibley St. Steam heating equipment will be installed in same. Total estimated cost, $1,000,000.

Mich., Detroit—The Veterans of Foreign Wars, c/o Henry M. Leland, Chn. of the Bd. of Trustees, 2984 West Grand Blvd., plan to build a 7 story club house. Steam heating equipment will be installed in same. Total estimated cost, $500,000. George Mason, 80 Griswold St., Archt.

Mich., Detroit—The Women's Hospital and Infants' Home, Forest Ave., plans to build a 3 or 4 story addition to present hospital on Forest Ave. and Beaubien St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mich., Eloise—The Wayne Co. Poor Bd., c/o O. P. Gulley, 27 Churchill St., plans to build a 4 story hospital and home. Steam heating equipment will be installed in same. Total estimated cost, $400,000.

Mich., Farmington—The village plans to install an electrically driven auxillary pumping unit and construct extension to water mains. Total estimated cost, $25,000. R. A. Murdock, 603 Free Press Bldg., Detroit, Engr.

Mich., Flint—W. L. Hoffman, Michigan School for the Deaf is in the market for a new electric driven d.c., 250 volt centrifugal pump.

Mich., Grand Rapids—The Grand Rapids Tire & Rubber Co., c/o H. H. Swan, Mgr., 315-18 Kelsey Bldg., is having plans prepared for the construction of a 2 and 3 story tire plant on Fuller Ave. and the Grand Trunk Ry. Electric power motors will be installed in same. Total estimated cost, $400,000.

Mich., Grand Rapids—The Y. W. C. A. has engaged Robinson & Campau, Archts., 715 Michigan Trust Bldg., to prepare plans for the construction of a 3 story administration building on Sheldon and Island Sts. A steam heating system will be installed in same. Total estimated cost, $200,000.

Mich., Muskegon Heights—The Bd. of Educ. will soon award the contract for the construction of a 3-story, 19 x 240 ft. school. Fan heating and ventilating systems, including a boiler, will be installed in same. Ammerman & McColl, 2348 Penobscot Bldg., Detroit, engrs. S. D. Butterworth, 432 Tussing Block, Lansing, Archt.

Mich., Pontiac—C. W. Hubbell, Engr., 2348 Penobscot Bldg., Detroit, will receive bids until May 17 for the construction of a 10,000,000 gal. filtration plant for the city. Two electrically driven sump pumps, motors, steam heating system, etc. will be installed in same. Total estimated cost, $500,000.

Mich., Pontiac—The Oakland Motor Car Co. plans to build a 2 story, 60 x 200 ft. service station on Baldwin Ave. Steam heating equipment will be installed in same. Total estimated cost, $250,000.

Ill., Chicago—The Clerk of the Sanitary Dist., 910 South Michigan Ave., will receive bids until May 13 for the furnishing and delivering 2 Diesel Oil engines, each direct connected to its engine type 500 kw., 3 phase, 60 cycle, 2,300 volt alternating current generator with direct connected exciter and 2 similar additional units.

Ill., Chicago—Straus & Schram, 1105 West 35th St., are having preliminary plans prepared for the construction of an 11 or 12 story mail-order plant on Western Ave. and 36th St. A steam heating system will be installed in same. Total estimated cost, $5,000,000. E. W. Eppstein, 2001 West 39th St., Engr. S. Scott Joy, 2001 West 39th St., Archt.

Ill., Freeport—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until May 6 for the installation of a new heating boiler at the Post Office, here.

Ill., Granite City—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until May 13 for the installation of a heating boiler, etc., at the United States P. O., here.

Wis., Milwaukee—The School Bd., 10th and Prairie Sts., is having plans prepared for the construction of a 1 story, 22 x 40 ft. boiler house at the Garfield School. Estimated cost, $50,000. Van Ryn & DeGelleke, Saswell Block, Archts. and Engrs.

N. D., Dickinson—The city plans to construct a 1,000,000 gal. reservoir, pump house addition, complete boiler plant for operating pumps and compressors and install additonal compressors. Total estimated cost, $40,000.

N. D., McVille—The City Council will soon award the contract for the construction of a 125,000 gal. reservoir and the installation of 3 pumps, etc. Total estimated cost, $36,000. Atkinson & Hall, Devils Lake, Engrs.

Tex., Big Spring—The city plans to rebuild the waterworks system, including new pumping plant, etc. A steam driven pump will be installed in same. Total estimated cost, $40,000. Henry Echod Eng. Co., Interurban Bldg., Dallas, Engr.

Tex., Dallas—The Dallas Auto Laundry & Storage Co., c/o Dick Spillers, Mgr., Dallas Auto Club, is having plans prepared for the construction of a 6 story, 100 x 150 ft. garage. A steam heating system will be installed in same. Total estimated cost, $250,000. Charles W. Almstead, Cleveland, O., Engr.

Tex., Dallas—T. Dies, Guaranty Bank & Trust Co., Commonwealth Bldg., is having plans prepared for the construction of a 12 story, 60 x 100 x 150 ft. office building on St. Paul, Elm and Pacific Sts. A steam heating system and power generating plant will be installed in same. Total estimated cost, $1,700,000.

Tex., Dallas—George M. Easley, Dallas, is having plans prepared by Lang & Mitchell, archts., Insurance Bldg., for the construction of a 10-story office building on Burlington and Bryan Sts. A steam heating system will be installed in same. Total estimated cost, $500,000.

Tex., Dallas—John T. Jones, 4930 Junius St., is having plans prepared for the construction of a 10 story, 100 x 100 ft. office building on Commerce and Prather Sts. A steam heating system will be installed in same. Total estimated cost, $750,000. Lang & Mitchell, Amer. Exch. Bank Bldg., Archts.

Tex., Fort Worth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to furnish and install deep well pumping equipment here. Estimated cost, $30,000.

Okla., Okmulgee—The Creek Hotel Co. will soon receive bids for the construction of a 9 story, 100 x 140 ft. hotel. A steam heating system will be installed in same. Total estimated cost, $750,000. Smith, Rea, Lovitt & Senter, 601 Finance Bldg., Kansas City, Archts.

Utah, Salt Lake—The city plans to build a pumping plant to deliver ultimately 52,500,000 gal. daily, using the Utah Lake as a source of supply, etc. Total estimated cost, $2,500,000. C. T. Brown, Walker Bank Bldg., Engr.

Wash., Everett—The Y. M. C. A. plans to build a 3 story, 114 x 115 ft. Y. M. C. A. building on Colby Ave. Plans include boiler rooms, steam bath-rooms, etc. Total estimated cost, $200,000. Baker & Vogel, Pacific Block, Seattle, Archts.

Wash., Puget Sound—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install reciprocating air compressors at the Navy Yard, here. Estimated cost, $50,000.

Ore., Salem—The Oregon Pulp & Paper Co. plans to construct a power plant on the site of the old Oregon Flouring mills known as the Scotch mill, at the foot of North Mill Creek to transit elecrtic energy to the paper mill on Trade and Front Sts. Estimated cost, $50,000.

M. I., Guam—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to construct a refrigerator plant, here. Estimated cost, $40,000.

Ont., Chatham—James St. Pierre, R.R., Bear Line, will soon award the contract for the construction of a pumphouse, etc., in connection with the land reclamation work for the Township of Dover. Total estimated cost, from $15,000 to $25,000. W. G. McGeorge, Consult. Engr.

Ont., Pembroke—S. L. Biggs, town clk., will receive bids until May 12, for furnishing and installing turbine pump and gasoline engine, with capacities of 1,200 gal. and 800 gal. per min. Estimated cost, $25,000. J. P. Howe, Town Engr.

Ont., Toronto—Eustace G. Bird, Archt., 9 King St., W., will soon award the contract for the construction of a 4 story, 70 x 400 ft. and a 2 story, 52 x 175 ft. factory building on Wallace and Ward Aves., for the Canadian General Electric Co., King and Simcoe Sts. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ont., Toronto—The Y. M. C. A., 21 McGill St., and the Dominion Council, 604 Jarvis St., plan to build a 4 story Y. M. C. A. building. A vacuum steam heating system will be installed in same. Total estimated cost, $650,000.

Sask., Moosomin—G. S. Page, Town Clk., will receive bids until May 5 for the supply and delivery of (A) Internal combustion engines, (B) generators, exciter, switchboard, street lighting apparatus, transformers, meters, etc., (C) 1 oil storage tank, (D) pole line and wire material, (E) erection of electric pole line, (F) erection of power station and cooling chamber.

CONTRACTS AWARDED

Mass., Brighton—Samuel Rudnick, 37 Fayston St., Roxbury, will build a 4 story 90 x 600 ft. apartment house on Buckminster St. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Work will be done by day labor.

Mass., Lawrence—The Patchogue Plymouth Mills Corp., Maston St., has awarded the contract for the construction of a 2story manufacturing plant addition, to L. E. Locke & Sons, 800 Bay State Bldg. A steam-heating system will be installed in same. Total estimated cost, $250,000.

Mass., Leominster—The Leominster Gas & Power Co. has awarded the contract for the construction of a 2-story 40 x 54 ft. addition to its power house, to Walter H. Preble, 11 Pemberton Sq., Boston. Estimated cost, $100,000.

Mass., Wellesley—The Academy of the Assumption, Wellesley Hills, has awarded the contract for the construction of a 4 story, 110 x 190 ft. college and tower on Worcester St., to the James Driscoll & Son Co., 94 Washington St., Brookline. A steam heating system will be installed in same. Total estimated cost, $350,000. Noted Jan. 27.

Mass., Whitinsville—The Whitin Machine Wks. has awarded the contract for the construction of a 2 story industrial housing building, to the Foundation Co., 232 Bway., New York City. A steam heating system will be installed in same. Total estimated cost, $350,000.

Mass., Worcester—The Osgood Bradley Car Co., West Boylston St., will build a 3 story manufacturing plant addition. Extension to the steam heating system will be installed in same. Total estimated cost, $325,000. Work will be done by day labor.

N. Y., Black River—The St. Regis Paper Co. will build a power house to generate 7,500 hp. on the Black River. Total estimated cost, $500,000. Work will be done by day labor. Noted April 6.

N. Y., Brooklyn—The Amer. Safety Razor Co., 303 Jay St., has awarded the contract for the construction of a 5 story, 75 x 140 ft. and a 1 story, 25 x 125 ft. factory buildings, a 2 story, 45 x 50 ft. garage and a 1 story, 25 x 50 ft. boiler house, to the Turner Constr. Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Noted Feb. 9.

N. Y., New Dorp—(Staten Island P. O.) The Bd. Educ., 500 Park Ave., New York City, has awarded the contract for the installation of heating and ventilating apparatus in the Jefferson, Garretson and Cromwell Ave. public schools, to Gillis & Geoghagan, 537 West B'way, New York City, at $58,700.

N. Y., New York—The Borden Milk Co., 63 Vesey St., has awarded the contract for the construction of a 23 story, 80 x 100 ft. office building on 45th St. and Madison Ave., to the Cauldwell Wingate Co., 381 4th Ave. A steam heating system will be installed in same.

N. Y., New York—The Bosch Magneto Corp., 233 West 46th St., has awarded the contract for installing a steam heating system in the proposed 12-story office and salesroom building at 60th St. and Bway., to J. O'Brien Co., Inc., 624 Madison Ave. (general contractors for job). Total estimated cost, $700,000.

N. Y., New York—The George Backer Constr. Co., 33 East 33d St., will build a 6 story garage on West 49th St. A steam heating system will be installed in same. Total estimated cost, $250,000. Work will be done by day labor.

N. Y., New York—The New York State Realty & Terminal Co., c/o Warren & Wetmore, Archts., 10 East 47th St., has awarded the contract for the construction of a 17 story hotel on Park Ave. and 49th St., to Fred T. Ley Co., 19 West 44th St. A steam heating system will be installed in same. Total estimated cost, $2,500,000.

N. Y., New York—John H. Sherer, 25 West 45th St., will build an 8 story, 55 x 60 x 118 ft. office building on 52d St., near B'way. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. Y., New York—E. E. Smathers, 304 West 75th St., will build an 11 story, 27 x 100 ft. office and store building at 1 West 46th St. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. J., East Orange—The Simms Magneto Co., 279 Halsey St., has awarded the contract for the construction of a 2 story, 154 x 167 ft. factory on North Arlington Ave., to the Amer. Concrete Steel Co., Essex Bldg., Newark. A steam heating system will be installed in same. Total estimated cost, $385,000.

N. J., Newark—Loew's Enterprises, 1493 B'way, New York City, have awarded the contract for the construction of a theatre building on Main St., to the Fleischmann Constr. Co., 551 7th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, about $300,000.

Pa., Philadelphia—H. C. Aberle, A and Clearfield Sts., has awarded the contract for the construction of a 5-story factory and power house, to W. Steele & Sons Co., 16th and Arch Sts.

Md., Dukes (Adelina P. O.)—The West Virginia Pulp & Paper Co., 200 5th Ave., New York City, will build a 90 x 150 x 100 x 120 ft. factory addition here. A steam heating system will be installed in same. Work will be done by day labor.

W. Va., Clarksburg—The city has awarded the contract for the construction of an intake chamber and the installation of a coagulating basin and equipment for pumping stations, to the Richards Constr. Co., at $37,108.

O., Cleveland—The Jordon Motor Co., 1070 East 152nd St., has awarded the contract for the construction of a 1 and 3 story, 70 x 620 ft. factory and a 34 x 48 ft. power house on East 152nd St. and St. Clair Ave., to the Hunkin Conkey Constr. Co., Century Bldg. Two 250 hp. boilers with coal handling machinery, bunkers and stokers will be installed in same. Total estimated cost, $300,000.

O., Dayton—The Bonebrake Seminary, c/o S. E. Fout, 1521 West 1st St., has awarded the contract for the construction of a 4 story, 90 x 225 ft. theological school on Calalpa and Cornell Sts., to H. J. Osbun, Salem Ave. Plans include a power plant, etc. A steam heating system will be installed in same. Total estimated cost, $750,000.

O., Dayton—The Peckham Coal & Ice Co., Daller and Chapel Sts., has awarded the contract for the construction of a 1 story, 112 x 137 ft. ice plant, to the Blanchard Constr. Co. Estimated cost, $60,000.

O., Marion—The Marion Packing Co. has awarded the contract for the construction of a 4 story, 42 x 84 ft. cold storage building addition to E. Elford, 104 North 3rd St., Columbus. Estimated cost, $120,000.

Mich., Detroit—The Bd. Educ. 50 B'way Ave., has awarded the contract for installing a heating, ventilating and plumbing system in the proposed school on St. Antoine St. and Palmer Ave., to James W. Partlan, 51 Park Pl., at $139,000. Noted March 9.

Mo., St. Joseph—The Missouri Methodist Hospital Association has awarded the contract for installing a steam heating system in the proposed 5 story hospital, to the Rock Plumbing Co., 115 North 3rd St. Total estimated cost, $600,000.

Tex., Waco—The Bd. of Trustees of the Methodist Church South has awarded the contract for the construction of a steam heating plant and laundry at the Orphanage, to William Smith, at $45,000. A Boiler, steam pipes, etc. will be installed in same.

Okla., Newkirk—The Newkirk Ice & Creamery Co. has awarded the contract for the construction of a creamery, to Arthur Frank, Tulsa, at $125,000. Two 150 N. B. and W. boilers, one 100 kw. a.c. direct connected, 230 volt, generator, etc. will be installed in same.

Ont., Toronto—The Canadian Natl. Carbon Co., 265 Adelaide St. W., and the Prest-O-Lite Co. of Canada, Ltd., 120 Elm St., have awarded the contract for the construction of a 2 story, 80 x 400 ft. and a 2 and 3 story, 80 x 400 ft. factory buildings at Hillcress Park, to Wells & Gray, Confederation Life Bldg. A steam heating system will be installed in same. Total estimated cost, $450,000.

Current Opportunities—

Positions Vacant
Surplus Equipment for Sale
Equipment Wanted
Positions Wanted
Second-Hand Equipment for Sale
Business Opportunities

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Some of the announcements in this issue may be of interest to you.

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